# SCHOOL SCIENCE

State Institute of Education,
P.O. Banipur, 24 Parganas

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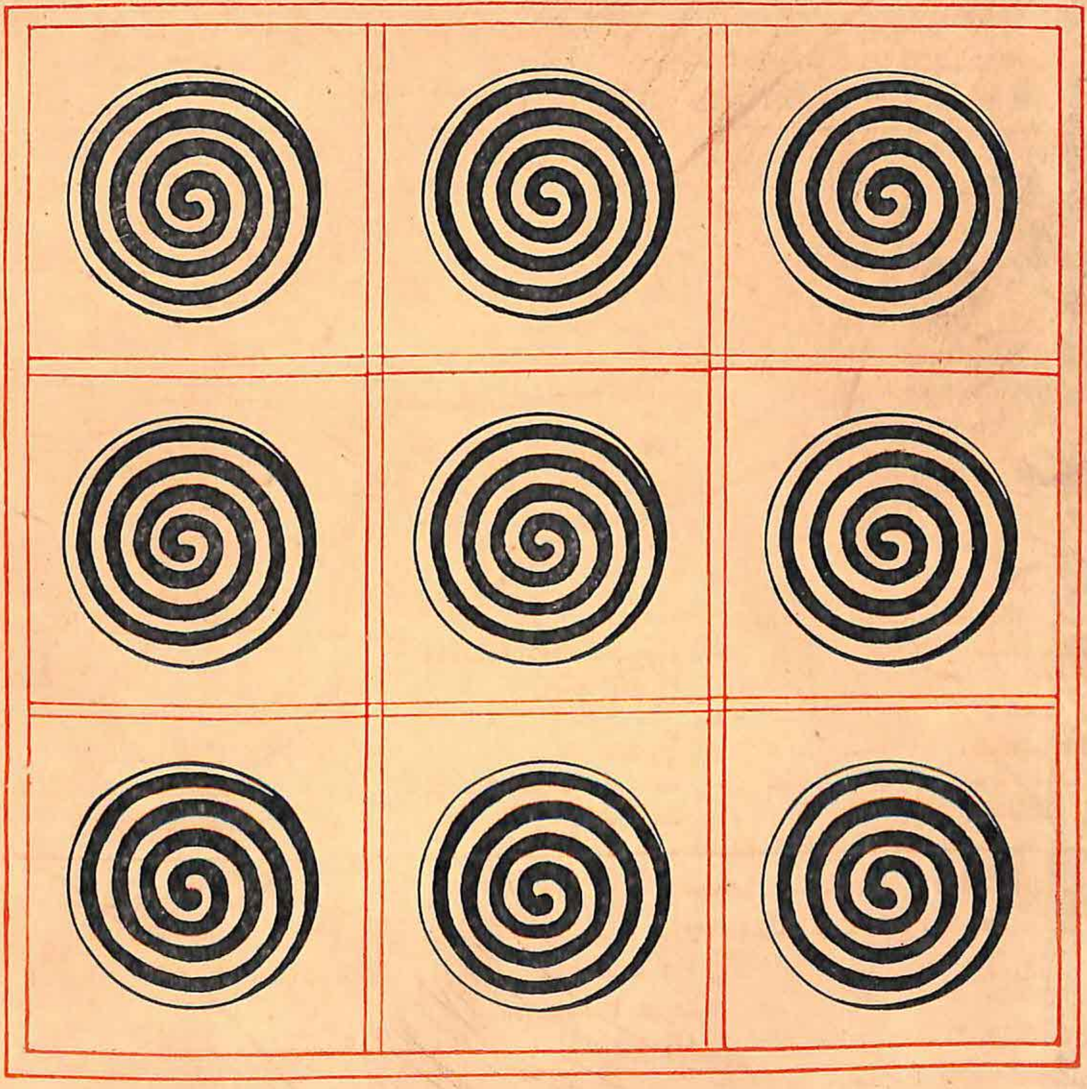

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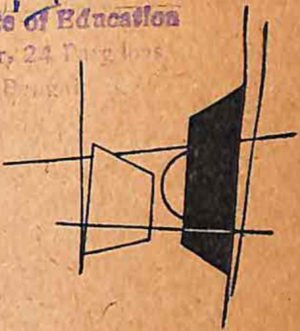

# School Science

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*March, 1981*

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# Three-Dimensional Pictures and Their Role in Education

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HAVE YOU ever wondered why you have two eyes? What does one loose when, unfortunately, one looses one eye? Try the following experiment :

Close one eye. Hold the forefinger of the left hand pointing upwards and that of right hand pointing downwards. Then try to touch the tips of the two fingers by seeing with one eye. You find that many times you miss the aim. The tip of upper finger comes either too close to you or too far from you. It is quite tricky and depends on chance that the tip of upper finger is at the same distance from your eye seeing it, as the tip of the lower finger. The reason for it is that when you look by one eye, you can't see depth, you can't make a judgement of distance.

Repeat the experiment with both eyes open and feel the comparative ease with which you can now touch the tips of the two fingers. Only rarely, if at all, you miss the aim. The reason is that by both eyes you can see depth and can make judgement of distance.

In Physics this phenomenon is called as *Stereoscopic vision*, because it enables us see three dimensions. It is also called *Binocular vision* because two eyes are required to see the depth.

How do we really perceive that an object is nearer to us than the other, by both the eyes?

Consider, first, two bodies A and B at the same distance from an observer whose eyes are L and R (Fig. 1). For simplicity of discussion let A and B be equidistant from N, the point representing nose and symmetrically placed about the line NX. The angle subtended by the objects at left eye (i.e. $\angle$BLA) is equal to that at right eye (i.e. $\angle$BRA).

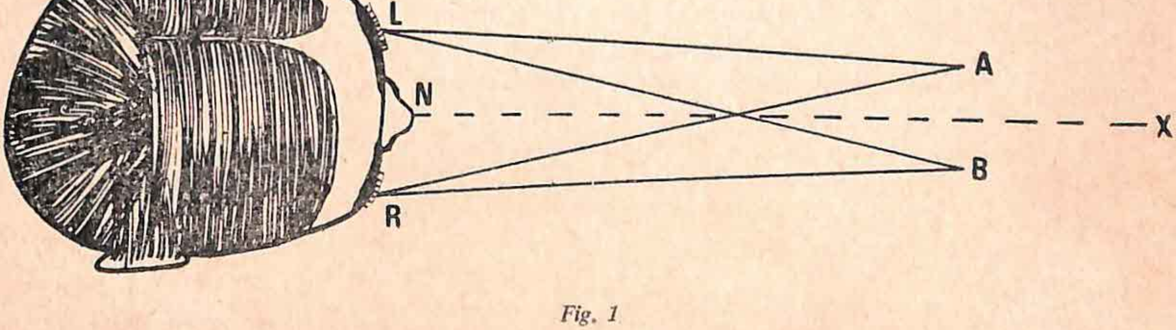

*Fig. 1*

Next, consider two bodies A and B at different distances (Fig. 2), the body B having shifted parallel to NX. In this case the angle subtended by the objects at the left eye (i.e. ∠BLA) is less than that at the right eye (i.e. ∠BRA). It is the difference between these angles by which the brain interprets that the object at left (i.e. A) is nearer and the other (i.e. B) is farther away.

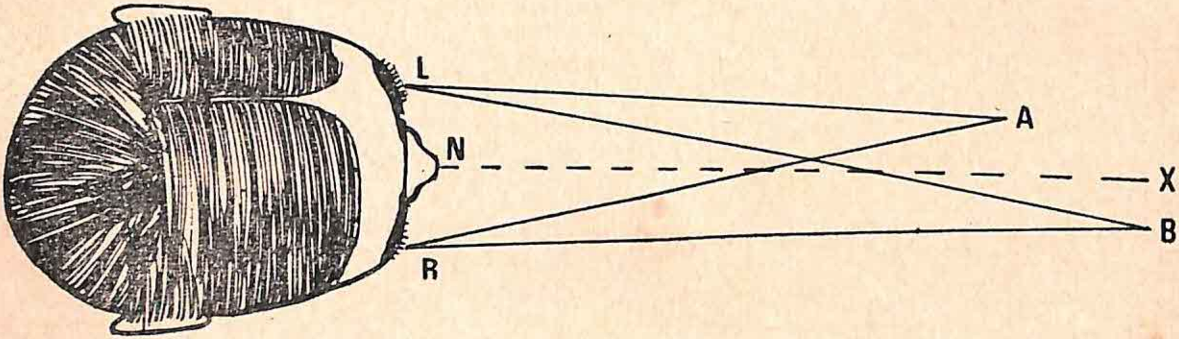

*Fig. 2*

Considering a full scenery before the eyes, we may say that the picture of the scenery obtained in the left eye is slightly different from the picture obtained in the right eye. By analysing the difference between the two pictures, the brain conceives the distance of various objects and thus blends the two pictures into a 3-dimensional image of the scenery before the eyes.

Now, if, instead of the real scenery, we have two photographs before the eyes such that the same image is reproduced in each eye as was produced by the real scenery, then again the brain will recreate the 3-dimensional image of the scenery. This, in brief, is the basic principle of 3-dimensional photography. Since it enables to make record of shape of objects in 3-dimensions, it is called stereoscopic photography, or briefly stereography.

Practical procedure of stereoscopic photography is, in a way, quite simple. In place of the two eyes we have two optically matched cameras L and R (Fig. 3). The two photographs so taken differ slightly. Distance between the lenses of the two cameras, d, is equal to the distance between the two eyes, so that the difference between the two pictures is the same as that between the pictures obtained in the eyes of a real observer.

Next, we make prints (or slides) of the two pictures. These are mounted in a viewer at $P_L$ and $P_R$ keeping the same distance d from each other (Fig. 4). The viewer (or stereoscope, as it is technically called) has two lenses L and R which are, again, at the same distance, d, from each other. Picture obtained by the left hand camera is kept before the lens L of the viewer and that obtained by the right hand camera is kept before the lens R. On viewing the two pictures by both the eyes, left eye looking through lens L and right eye looking through lens R, we see an image of the scenery in its 3-dimensions.

## Some Pertinent Questions

A few questions must be asked here before we can be really clear about the whole technique.

Q. 1. If we look at one picture (or slide) by one eye through a magnifying glass, it seems to give us an idea of depth too. Is it then, per-

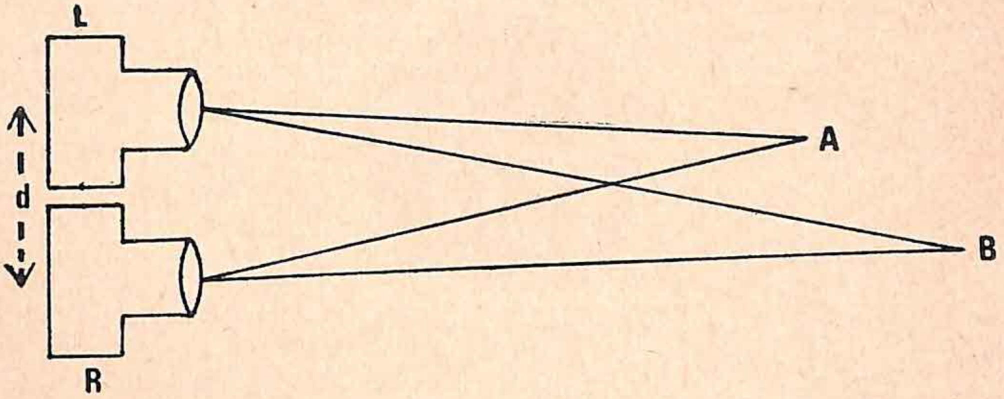

*Fig. 3*

haps, the effect of lenses in the stereoscope which provides the perception of depth?

A simple answer, in authors' view is that perception of depth cannot be associated with the lenses. It is essentially located in the two pictures—in the slight difference between the two pictures. In fact it is possible to eliminate the lenses altogether in viewing the stereoscopic photographs, as follows:

Make two equally enlarged and laterally inverted prints of the two pictures. Mount them at $F_L$ and $P_R$ in a stereoscope based on plane mirrors (Fig. 5). The mirrors $M_L$ and $M_R$ are preferably front surface silvered. Left eye L looks at the picture $P_L$ through the mirror $M_L$ and the right eye R looks at the picture $P_R$ through the mirror $M_R$. Virtual images of the two pictures coincide in the plane P. Then the observer sees a 3-dimensional view of the scenery photographed.

In the above explanation it is not intended to say that in one picture we cannot perceive depth at all. Certainly we have some perception of depth in a single picture also, due to some other factors. Major ones among these factors are our past familiarity with the objects in the picture and their relative size. The farther away an object is, the smaller it appears in the photograph. Another important factor is that

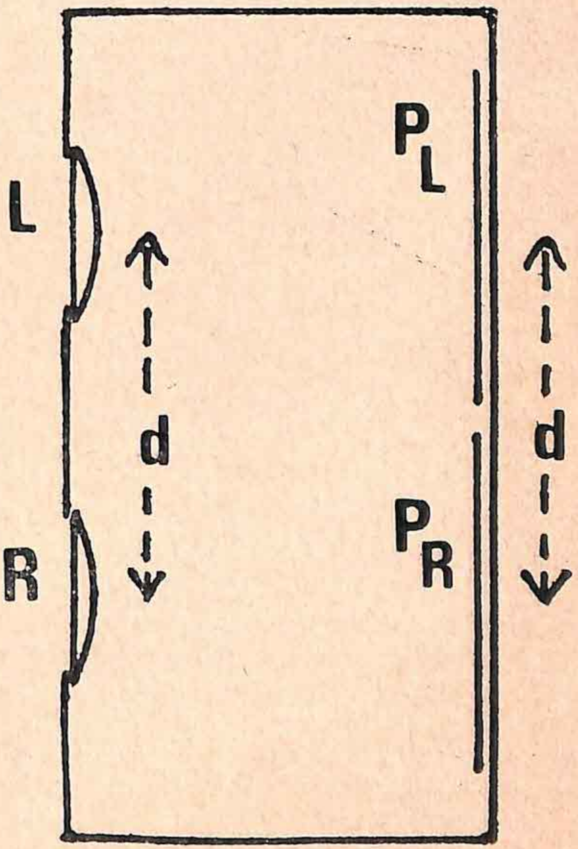

*Fig. 4*

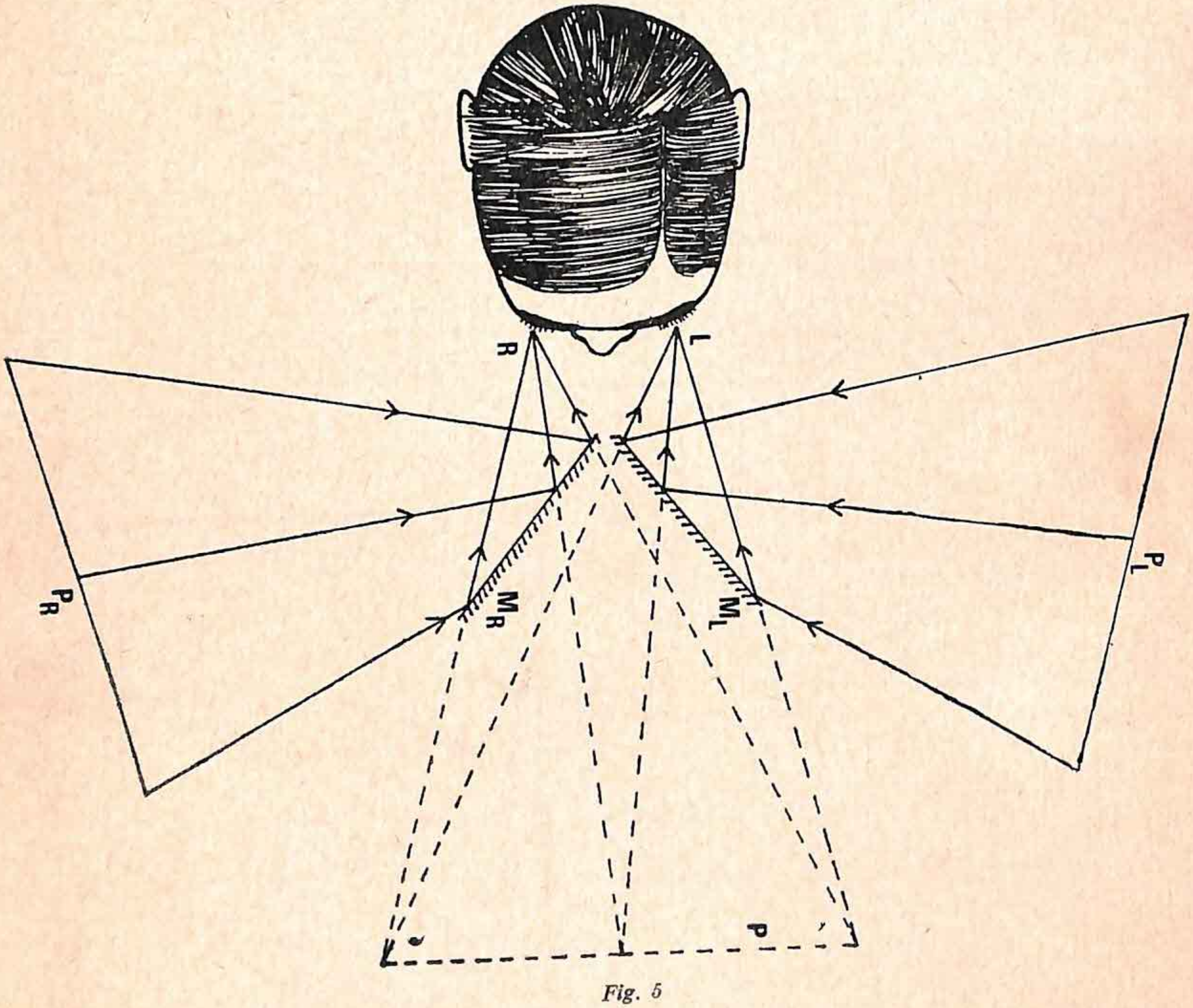

*Fig. 5*

when by one eye we see a near object, a distant object is out of focus. Thus the process of accommodation helps us to see objects at various distances distinctly and at the same time, to form an idea of distance.

Q. 2. Another important question is that where does the blending of the two pictures take place? Does it happen in the optical system of the stereoscope or in the brain?

The process of blending can, in fact, be supposed to consist of two stages:

(a) Overlapping virtual images of the two pictures are formed by the optical system of the stereoscope. Thus in the virtual image of the photograph taken by the left hand camera, each object is in the same direction in front of the left eye of the observer, as it was in the real scenery in front of the camera. Similar statement holds true for the right eye.

(b) When the images are seen by the observer, each image is seen by respective eye and then the brain blends the two pictures into a 3-dimensional image. If it so happens that each image is seen by both the eyes, then the brain

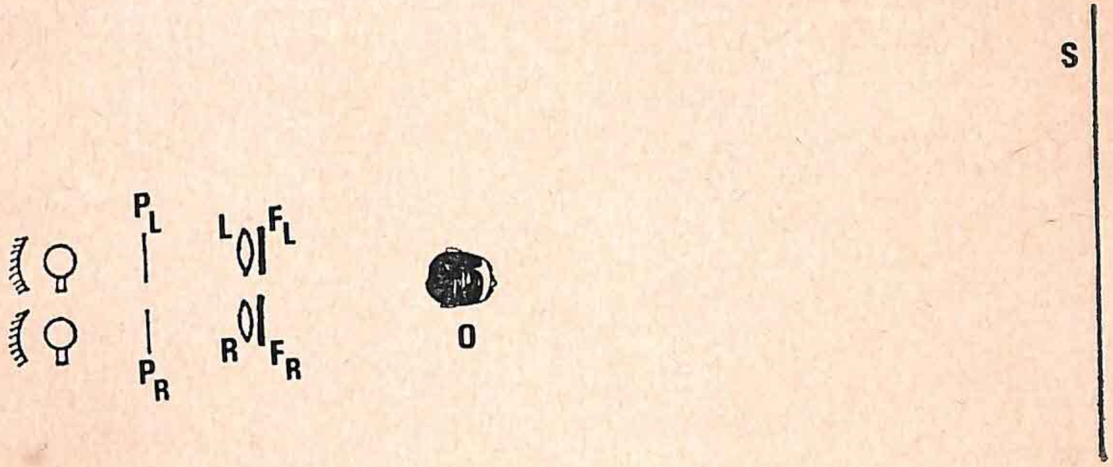

*Fig. 6*

fails to blend them into a 3-dimensional image and one can see only a blurred plane image.

### Projection of Stereoscopic Pictures for Group Viewing

The second question discussed above leads us to the principle of projection of stereoscopic pictures.

Suppose we have a pair of projectors, whose projecting lenses are L and R (Fig. 6). The stereoscopic pair of pictures $P_L$ and $P_R$ are placed before the respective lenses and projected on the screen, S. In order that the observer O sees the image of $P_L$ by left eye only and the image of $P_R$ by right eye only, filters $F_L$ and $F_R$ are placed on the lens L and R respectively. The filters polarise the light passing through them. Plane of polarization of $F_L$ is perpendicular to that of $F_R$. The observer O sees the projected images by a pair of 'spectacles'. The left lens in the spectacles is a polariser with its plane of polarization paralleled to that of a filter $F_L$. This lens does not permit the light of projector R to pass through. Thus left eye of the observer sees the projected image of $P_L$ only. Similar statement holds true for the right lens of the spectacles.

### Three-dimensional Pictures in Education

By a 3-dimensional picture, the shape of the original object in 3-dimensions can be far more easily and accurately comprehended than by the usual 2-dimensional picture. For study of such objects in which the shape in 3-dimensions is important, such pictures are a much better teaching aid than 2-dimensional pictures, e.g. historical structures and architecture, complex machine or apparatus or instruments, human body, solid geometry, etc. In these areas of study, a structured instructional programme for individualized learning, employing 3-dimensional pictures at suitable places in the programme, can be far more effective than the one having exclusively the usual 2-dimensional pictures, specially for lower ability groups.

### A Word of Caution

The Guinness Book of World Records states under the heading *Highest Wave*, "A stereo-photograph of a wave calculated to be 81.7 feet high was taken from the USSR's diesel-electric vessel . . . " Thus it would be clear that an accurate stereo-photograph can be used not only to see depth but also to measure distance and size of an object in the photograph.

It may, however, be cautioned that to make good stereo-photograph is a delicate art. Referring to Fig. 4, even an error of 1/10th of a millimeter anywhere can cause a serious distortion in the view being seen through the lenses. Inaccurate work can easily become a cheap trade, which may give an entirely wrong idea of the shape of things presented in the photograph.

### *Acknowledgement*

Thanks are due to the Workshop Department, NCERT and in particular to Shri Rakesh Kumar of development section of that Department for assisting the authors to make stereo-viewers which made a display of 3-dimensional pictures at the National Science Exhibition for Children, 1980 successful. ☐

# Illusion

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IF YOU have ever tried to catch a gold fish with your hands, you know that the fish is not where it appears to be. Why is this so? The fish fooled you because the rays of light reflected from it were bent as they passed from the water to the air. For the same reason, a pencil submerged in water looks crooked or bent. This bending is due to refraction of light. The bending one observes is not true but it is apparent or an illusion. Very few scientists, except a few experimental psychologists, consider such illusion as being of any real significance in science. This lack of appreciation of illusion may hamper the work of scientists very badly, particularly the work of biologists. A biologist is often obliged to make an estimate rather than exact measurement of the object under study. Thus he becomes a victim of illusion, unless he is aware of the existence of these pitfalls.

Illusions are special experience in which information arising from real external stimuli leads to an incorrect perception or false impression of the object (or event) from which the stimulation comes. These illusions or false impression may arise from factors beyond an individual control like the behaviour of light or from the functional and structural characteristics of sensory apparatus. If one looks round one may come up with various types of illusion. Illusions may be classified in various ways. A few examples of illusions will be illustrated here.

## Auditory Illusions

If a person stands on a railway platform and hears the sound made by an approaching railway engine, he will find that the pitch of the sound gradually increases as the engine approaches the observer and then the pitch gradually decreases as the engine recedes away from the stationary observer. The changing of pitch of the approaching and receding engine is an illusion. (In physics it is said as apparent change in the pitch.) This effect is called as Doppler effect.

A murmur may sound loud when compared to a whisper. This is because when two sounds are heard in close succession we tend to compare the loudness of the second sound with the first and hence the illusion. Many times the hum of an electric fan diffuse the street noise and helps us to improve the discriminating power of the sound in the room.

## Optical Illusion

Illusion includes the colour contrast phenomenon. If one looks at red colour first and then to green colour, one feels that the brightness of green colour is much more than that of red. This one may experience when one goes to buy cloths in shops which are artificially illuminated.

Another example of colour illusion one may come across is when one enters dark room from bright sunshine. As soon as one enters the dark room, at first it seems to be quite dark by contrast. This phenomena one realises when one enters into a theatre after the show has started.

The optical illusion is due to the behaviour of the light. Any number of examples may be quoted to illustrate this phenomena. One such example is illustrated in the beginning. A few more examples will be illustrated.

Every student of science is aware of the formation of mirage. The mirage is observed when one is travelling on a concrete asphalt road on a hot day. Here one observes that the road at a distance appears to be covered with pools of water. This is an illusion caused due to refraction of light rays by layers of hot air just above the heated ground.

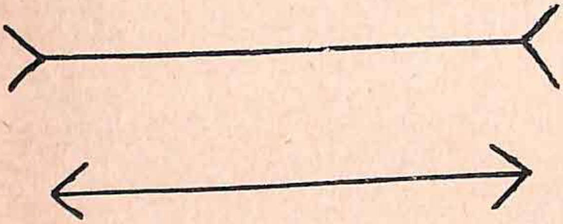

*Fig. 1*

Another example one may observe is the formation of rainbow. Here the light rays suffers both reflection and refraction by rain drops as a result of which the sun rays are resolved into its component colours. To observe the rainbow one has to look at the sky keeping his back towards the sun.

Another example of illusion is the twinkling of stars. When observed with naked eye, you find fluctuation in the brightness of stars. This is an illusion. The fluctuation is not due to anything that is taking place in the star itself but it is due to the bending of starlight as it passes through the various shifting layers of hot and cold air in the atmosphere.

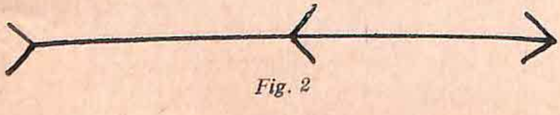

*Fig. 2*

At sunrise and sunset we see the sun. Again it is an illusion. Actually the sun is below the horizon. The refraction of light by the earth's atmosphere makes it possible for us to see the sun when it is actually below the horizon.

If you observe the moon when it is at the horizon and when it is fully risen, you find an apparent difference in the size of the moon. The horizon moon is actually farther away from the observer, still it looks much larger than it does when it is high in the sky and closer. One explanation that is attributed to this difference in size is that the fully risen moon cannot be readily compared to the terrain, as it can at the horizon.

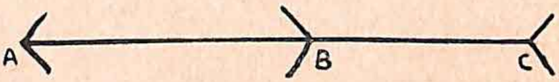

*Fig. 3*

If you watch a movie you get the illusion that the pictures are uninterrupted motion of the objects. What actually happens is that the still pictures are projected rapidly at a rate of 24 frames per second and due to persistence of vision we feel that the movie is continuous. Similarly if electric bulbs are arranged in a line,

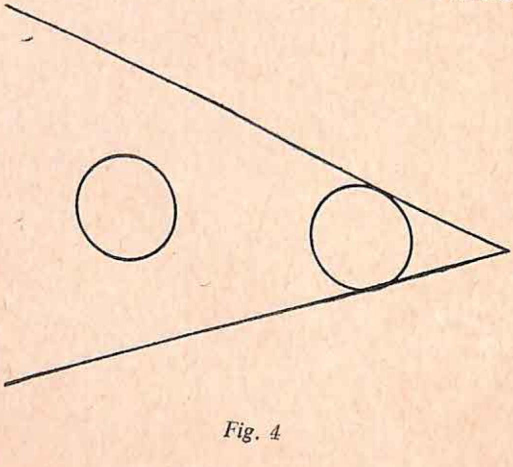

*Fig. 4*

and the bulbs are lighted one after another one gets the illusion of moving lights.

### Geometrical Illusion

The geometrical illusions arise essentially through a combination of an actual defect in observation together with a faulty psychological interpretation. These illusions mislead us to make false estimate of length, area, angle and curvature. These illusions are most effectively exploited by artists.

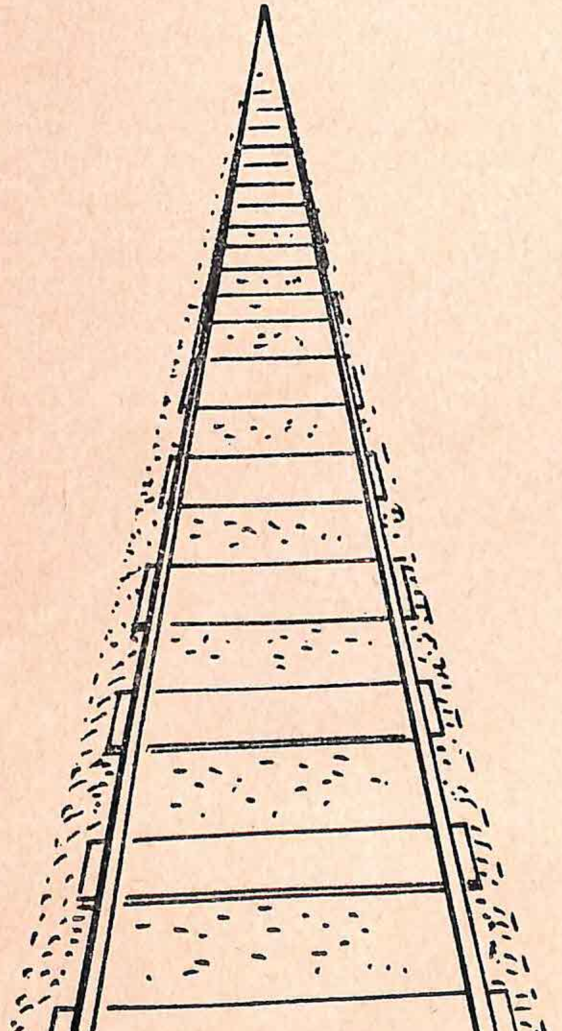

*Fig. 5*

Look at Fig. 1. In this figure the converging arrowhead looks shorter than that with the diverging arrowhead. However if you take a scale and measure, you will find both the horizontal lines have identical lengths. In one case the arrowhead draws the eye inwards and in another case outwards. So one line appears to shorten, the other to lengthen. The combination of the lines (Fig. 2) creates an illusion that one line is longer than the other. One can judge the error by drawing the line and segments in such a way that it looks equal (Fig. 3). Measurement shows that AB is longer than BC and from this one can calculate the error. This mechanism for illusion is called Gestalt principle of convergence and divergence.

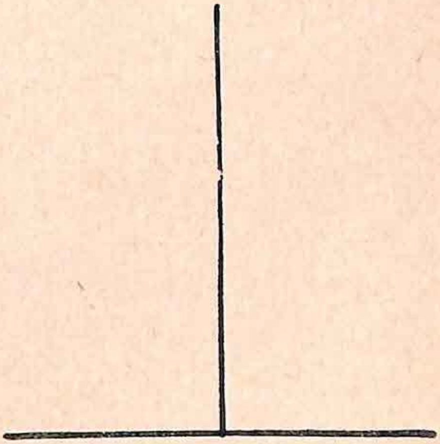

*Fig. 6*

A figure seen touching converging lines as in Fig. 4 creates an impression of larger size than does another figure placed between the lines where they are farther apart. Similarly linear perspective creates the illusion that paral-

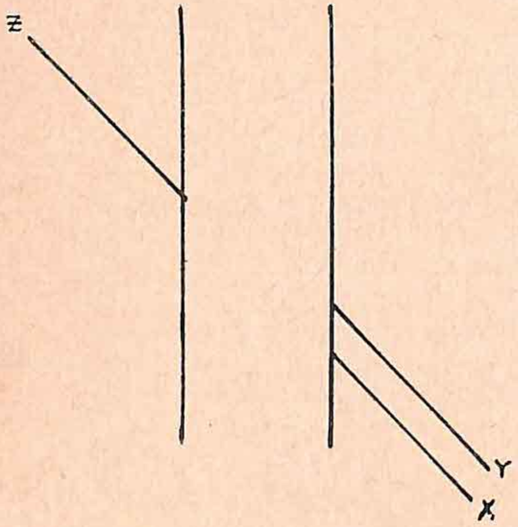

Fig. 7

lel lines or contours (like a rail road) converge as they recede from the viewer (Fig. 5).

Examine Fig. 6. Two lines are drawn, one vertical and the other horizontal. The horizontal line is bisected by the vertical line. Your assessment will be that the vertical line is bigger than the horizontal line. If you take a scale and measure you will find that both the lines have identical length.

In Fig. 7 you find a broad band being crossed by two parallel lines indicated as X, Y and Z. Your inference after looking into the figure would be that Y and Z are in the same straight line i.e. the line Z is the continuation of the line Y. The figure has misled you. If you apply a straight edge to the line, you will find that X and Z and not Y and Z which are colinear. □

# The Mathematical Sentence

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WHEN WE speak or write, we use sentences to express our ideas. To express mathematical ideas we write sentences using numerals, placeholders and symbols. The primary function of mathematical sentences is the solving of problems. Mathematical sentences answer many questions which may be as simple as, 'How many books do you have?' Or more complex such as If $5 > 3$ then $5+1$ is... A mathematical sentence is the translation of a problem from its verbal form to a mathematical form.

To understand the nature of mathematical sentences, one must be familiar with the vocabulary of mathematics—its nouns, its verbs, and symbols. Symbol, a mark, a sign or a word that we write in order to communicate with one another, is an essential tool for mathematical sentence.

The following symbols stand for the verbs in the writing of the mathematical sentences :

$=$ means equal to
$\neq$ means is not equal to
$<$ means is less than
$\leq$ means is less than and equal to
$>$ means is greater than
$\geq$ means is greater than and equal to
$\sim$ means is similar to; is equivalent to
$\cong$ means is congruent
$\Sigma$ means is an element of
$\subset$ means is a subset of

The sentence $5+4 \neq 6+1$ asserts that '$5+4$' and '$6+1$' are not names for the same number. The sentence $5+4 < 10+1$ asserts that the number $5+4$ is less than the number $10+1$. In addition to the symbols above discussed there are also the verbs which indicate negations. Substitution of '$\neq$' for '$=$' in a sentence produces the negation of that sentence. A similar relationship holds between '$<$' and '$\nless$' and '$\nleq$' and so on.

Another group of symbols, serving as conjugations, indicate the manner in which pairs of numbers are to be joined, or separated. Examples of these are:

$+$ Addition
$-$ Subtraction
$\times$, . Multiplication
$\div$, $\surd$, $\frac{0}{0}$ Division
$A^2$ Exponent or power
$\surd$ Radical (square root, cube root. . .)
$\cup$ Union
$\cap$ Intersection.

Examples of symbols which are used as nouns are :

$\angle$ Angle
$\triangle$ Triangle
□ Square
○ Circle

Symbols that describe the relationship between nouns, but do not indicate the operation to be performed, act in the same manner as adjectives. Examples are :

$\parallel$ Parallel (lines)
$\perp$ Perpendicular (lines)
$\times$ Intersecting (lines)

The sentence $\overleftrightarrow{a} \parallel \overleftrightarrow{b}$ means line 'a' is parallel to line 'b'. These symbols are usually used in geometry.

Symbols are used also to indicate measures like metre, gram, and degree, etc. when these terms are used as nouns in sentences. In the sentence like $4+\square=6$, $\square$ is called placeholders and 1, 2, 3, 4 . . . are called numerals. These are the punctuation symbols. As in English we use punctuation to avoid the confusion of meaning, for example the use of comma changes the meaning of these sentences.

Don't tell Ravi. Don't tell, Ravi.

Similarly, we use punctuation in mathematics to avoid confusion, but instead of periods and commas we use parentheses, brackets and braces. These symbols tell us which operation is performed first.

Most of the symbols above discussed have just one meaning each. Here is a mathematical sentence using six different symbols.

$$4+5-1=3\times3-1$$

All these symbols have specific meaning. But the language for operating with signed numbers involves double meaning for some symbols. For example 'plus' and 'minus' symbols are also positive and negative symbols that show direction. Use of signed numbers requires a clear and accurate understanding of such fundamental concepts as the commotative, associative and distributive properties and those involving multiplication by one and by zero, addition of zero, negative number as the opposite of positive number and subtraction as the opposite of addition.

The rule of order in writing a mathematical sentence is very important concept and should be developed very early in the elementary school by the following sequence of steps: In a sentence always do the operation inside parentheses, then follow the order of appearance for multiplication and division and then addition and subtration. The fraction line in complex fractions operates in the same manner as parentheses. Numerators and denominators in any expression must be cleared before dividing.

**Types of Sentences, Variables**

Sentences being a part of statement may be either closed or open. A closed sentence is a completed statement and may be either true or false. An open sentence is not complete statement. It may lack a verb, a noun or a conjunction. When the value of a noun has not been definitely established, it is called a variable. Once the value of a variable has been established, the open sentence becomes a closed sentence. Symbols that stand for specific and unique objects are called constants. All numerals are constants.

Examples of closed sentences:

| | | | |
|---|---|---|---|
| $6+3=9$ | True | $6+3\neq9$ | False |
| $5+5=5$ | False | $5+5=10$ | True |
| $3<5$ | True | $3<5$ | False |

Examples of open Sentences :

$5+x-9=16$

$\square.4=20$

$1<x>5$

$\frac{X}{9}=4$

**Compound Sentences**

We have discussed the verbs, nouns and other symbols for constructing sentences. Sometimes sentences are combined to describe a deductive argument. Sentences formed by combining or joining sentences in certain ways are called compound sentences. We shall discuss two types of sentences briefly.

1. *Conjugations* : When two or more sentences are joined by the word 'and', another sentence is formed. For example. If the sentence 'three is a prime number' is joined with 'two is an even number' with the word 'and' we get the sentence.

Three is a prime number and two is an even number. Such a compound sentence is called the conjunction of two sentences. The symbol $\wedge$ is used in place of the word 'and'.

2. *Disjunctions* : Another common connective word is 'or'. It is the second logical connective. A sentence which is formed by joining two or more sentences by 'or' is called the disjunction of those sentences. The symbol 'V' is used in place of 'or'. For example. Are you sure to get distinction in English or mathematics ? The two connectives 'and' and 'or' have proved to be the only ones of their kind needed in logical discourse.

### Use of Sentences in Problem Solving

The translation of problems into mathematical snetences requires an adequate knowledge of the nature of the problem. For example, consider the simple problem.

Ravi has a sheet of 50 stamps. If he uses 20 to mail invitations to his party how many will he have left?

The translation should read

$$50+X=20$$

$$\text{or } 50-20=X$$

In teaching your children to write rigid insistence upon a specific form may detract from the quality of thought. In mathematics one must allow for flexibility in the problem-solving approach. The maturity of the pupil will determine to some extent the degree to which the more precise form should be used. □

# Some Practical Problems Faced by the Teachers while using the Environmental Studies Approach in the Primary School Curriculum

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THERE ARE certain practical problems that a teacher faces while teaching through the Environmental Studies approach in the primary classes. Of course the problems appear more for teachers teaching through this approach for the first time; as the teacher becomes experienced, planning and organizing the work becomes easier. In fact a great many teachers get concerned that it is not possible to introduce environmental studies into a time table which is already overcrowded. This stems from the wrong notion that instead of an approach of teaching, environmental studies is just another subject which requires its own slot in the curriculum along with other subjects. At the initial stages of introduction to the curriculum it is advisable to allocate a limited period of time, perhaps one or two afternoons a week to environmental studies. This enables both the teacher and the children to adjust to the new pattern of work while more familiar work takes up the majority of the time. The time allocated to environmental studies can gradually be extended later on till it becomes a significant element in the school day.

One of the major problems that a teacher faces in teaching through this approach is the selection of a topic from large number of alternatives. A proper topic should answer some of the basic questions which may occur to the teacher :

(a) Whether the topic is suitable for the age and ability range of the children and whethere the topic is interesting enough for the group.

(b) Whether the topic provides wide range of activities both creative and scientific and whether it will act as a good starting point for introducing new skills, ideas and lead to studies of other environments.

(c) How practical is the topic in terms of equipment, reference material, time etc. and how far does the topic link with previous work and work planned for other areas of the curriculum.

A criticism often received about the choice of topic is that children are expected to study the local environment every year and consequently they become bored with the repetitive nature of the work. Where this occurs, the environmental studies programme has not been properly thought out: the programme has usually degenerated into the pursuit of local studies as an end in itself and the environment has not been used as a means of helping the children to develop and use skills in practical situation.

After the proper choice of the topic, at the planning stage, the task of the teacher becomes simple if a flow chart is prepared for reference purposes, for organizing the activities. Example of one such chart is given below :

(a) Aim of study
(b) Preparation by the teacher—
  (*i*) Outline of work schedule
  (*ii*) Preliminary field survey by teacher
  (*iii*) Planning the field work
  (*iv*) Collection and organizing reference material and equipment needed for the study.
(c) Introduction to study—
  (*i*) Introductory talk by the teacher followed by discussion with children.
  (*ii*) Division of children into working groups and allocation of responsibilities.
(d) Field work by children along with the teacher
(e) Work in school by children using field work data, reference material etc. and help from teacher as and when needed. The teacher may want to invite relevant outside speakers at this stage.
(f) Conclusion of study
(g) Evaluation of children's work and progress by the teacher.

The outside visit by the children is a particularly difficult hurdle for those teachers who have large classes and who are not accustomed to working outside the classroom. It must be emphasized that environmental studies does not consist only of a series of such visits and if need be outside visits can be restricted to about two or three in the whole term. But in any case, it is not advisable for any teacher to take out more than about 20 children without at least one other adult helper. The problem of escorts may be overcome by cooperation between members of staff, but, school authorities allowing, help of willing parents can be sought in this stage also. It is true that depending on the environment some teachers will be faced with a far greater challenge in this respect than others. Also, some environments are more richly endowed with material for environmental study programme than others. To children from the cities the known world is almost entirely man-made, it is the detail of this environment which must form the basis for much of the work in school. Shops, buildings, building material, local services, transport, the growth of the neighbourhood, traffic signs and many other aspects of urban living provide useful starting points for environmental studies. In the cities there may not be a local farm to study, but may be a fire station or a small industrial set up which can prove equally fascinating and rewarding. Also, the past is as much in evidence in a town as it is in a village. Houses, factories, ancient monuments or even monotonous rows of buildings in the congested parts of the cities can be used as starting points for environmental studies work. All environments, both urban and rural therefore offer considerable opportunities for practical work in and out of school. If it is kept in mind that in environmental studies one is concerned more with the methods of learning than the content, the potential of some of the less 'exciting' environment becomes increasingly apparent.

After returning from the field visit, once the children are back in the school, each group of children should be given the opportunity to develop and expand their study and should also be given opportunity for cross-reference with other groups. Whenever possible, collective thinking among children should be encouraged.

While evaluating children's work at the end of the study, the teacher faces certain problems since evaluation is more difficult in the environmental studies approach than in the traditional methods. This is true specially if the school concerned and the parents prefer teachers to evaluate children's work by marks rather than by general comments. As far as the attitude of the parents are concerned, it helps if parents could be invited to exhibitions and activities by children which forms the focal points of the studies. This gives them some idea of their children's progress. Though, it should not come as a surprise to the teacher, if at the beginning the parents prove to be unsympathetic. However, it may be pointed out, that certain aspects of children's work in environmental studies can be measured by traditional methods. Children's mastery of many skills can be tested objectively, answers to factual questions related to observation and experiments made by the children can also be assessed. It is also possible to give marks for creative work in writing, art and craft. But the teacher should remember that the value of the environmental approach does not come from the accumulation of facts about the locality which must be memorized for a 'test' since much of the work in environmental studies is concerned with attitudes and attainments which require more subjective assessment and cannot be evaluated by marks. But, one can perhaps jot down some pointers which may help the teachers to judge individual progress of children taught through this approach. While evaluating, the teachers could perhaps consider :

(a) Whether the child showed and sustained positive interest in the study.

(b) Whether the child became more observant and enquiring as the work progressed and whether this lead to a greater readiness to read.

(c) Whether the child was cooperative socially in the course of the work and whether there was any increase in the awareness and interest of the child in the environment.

The ultimate success or failure of environmental studies is in the hands of the teacher. If it is used as a means to accumulate basic facts about local history, geography or science, then this programme will be a failure. If however, work on the local environment is truly inter-disciplinary and involves considerable amount of first-hand experience to capture the quality and unity of the surroundings, then the programme should succeed and be widely accepted as a valuable part of the school curriculum. ☐

# Mental Health Problems Amongst School Children

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HELPING CHILDREN with psychological problems is not a prerogative of the mental health experts alone. Any one who deals compassionately with children can be of great help in alleviating their distress through early recognition of problems. To carry out the tasks of early recognition and referral to appropriate agencies the following guidelines focusing on different issues like the nature of emotional problems manifested by children and adolescents, mental health services offered at child guidance clinics and the vital role played by school social workers may be helpful to the teachers, school administrators and parents.

Emotional problems manifested by children and adolescents basically are of two types:

(1) Those manifesting as behaviour disturbing others such as aggressiveness, stealing, truancy, etc.
(2) Those experienced subjectively as distressing such as fearfulness, timidity, moodiness, depression, nail biting, etc.

Many of the problems may often be temporary and just a passing phase. When they are persistent or excessive they require attention. Problems arise because of child's basic personality or due to stresses in the environment caused by family members, teachers and peers or financial or social pressures of any kind.

Apart from the emotional and behaviour problems, children may have repeated physical illness without demonstrable diseases which may be a sign of underlying emotional disturbance. Examples of this are asthma, headache and similar other physical illnesses.

One of the most important problems faced by the school authorities in developing countries is academic backwardness. The reasons for this may be poor potential intelligence, sensory motor handicaps (poor hearing vision etc.), lack of interest in studies in a child who is quite talented otherwise, change in the medium of instruction or medium of instruction being other than the mother tongue and lastly inadequate teaching and rigid educational system. In addition, the child may have specific reading and writing disabilities, difficulty in organizing material or developmental lag.

Sudden drop in performance in a previously bright or average child may be due to certain emotional problems related to stresses and strains at home and school, anxiety or fears of a growing youngster and shift of interest from school to something else outside (seeking friendship particularly heterosexual relations during adolescence). Thus before labelling a child as backward one has to look for factors contributing to it.

Children may not manifest the same kind of problems at all ages. In a pre-school or primary school set up, the child needs to be sheltered as he is more dependent on a grown-up; separation from the mother is a big crisis for him.

During pre-adolescence, children generally show the best of behaviour and are friendly.

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*Lecture delivered to the participants of seminar on school health held on 28.8.1980 at NIMHANS, Bangalore.

They may become competitive in a healthy fashion.

Early adolescence is marked by moodiness, irritability and aggressiveness. Justice becomes an important issue. Signs of anxiety may manifest in the form of sleep walking, sleep talking or nail biting. They may also experiment with drugs or alcohol. This is quite normal but if the youngsters become addicted or dependent on drugs it may lead to serious consequences. They may require the help of a psychiatrist. But one can do a great deal by persuading the youngster to seek help and maintain a good follow up.

Adolescents also display a variety of sexual interests. These are :

(1) *Masturbation :* It is a normal passing phase commonly found during adolescence.

(2) *Homosexal interests :* This is less common and again is normal for many youngsters. If persistent, it is often accompanied by other emotional problems.

(3) *Heterosexual interests :* In developing countries like India, the normal psychological phenomenon manifesting as interest in opposite sex which is associated with physiological changes during puberty may be viewed with censure by the adults in the youngsters' environment. Adolescents need sympathetic handling and help and at the same time the need to confirm to norms of the society must be made understood to the youngster.

*Speech Problems :* There is a variety of problems or difficulties in communication which may cause distress to the child and become a permanent handicap. There may be delayed language development due to partial deafness (which may recover with time), misarticulation, stuttering or stammering and hoarse voice which if detected early (sometimes even later) may be treated effectively by a speech therapist. One can help the stammerer by not making fun of his speech, not avoiding his eyes, not prompting and by giving time to talk and by talking of topics of interest to him.

In addition to these emotional and behavioural problems, children are affected with a commonly known condition called epilepsy or fits which can be controlled with right kind of drugs. Fits are caused by electrical discharges in the brain and each fit causes some damage to the brain. Thus untreated fits lead to poor memory and intelligence, personality problems and serious mental illness in extreme cases. With regular medication over a long period, fits can be almost controlled. A child with fits under control can function like any one else. If a child gets fits, space around him should be cleared and he should be made to lie down sideways so that he does not choke. He should not be given anything to drink and nothing should be put in between the teeth.

Apart from what is described above, children may develop serious psychiatric disturbances and may have to be taken to a child guidance clinic wherein the coordinated services of psychiatrist, psychologist and psychiatric social worker are available.

*Children in Psychiatric Clinic :* The model employed here is based on the functioning of the child guidance clinic at the National Institute of Mental Health and Neuro Sciences, Bangalore.

A Psychiatric service for children enables the assessment, diagnosis and treatment of all children and their families, who show evidence of mental illness or emotional disturbance. In addition to these basic functions it provides consultation, advice and support for related services and specialized establishments and also participates in the training of professionals in related disciplines. A child guidance clinic functions as a referral service, coordinating health services for children in liaison with neurologists, paediatricians, general practitioners, schools, special schools for handicapped, orphanages, and other child welfare agencies in the community. Although hospital services are an essential element of a psychiatric service for children, a shift into the community—the home, the school, health centre or other community base is considered necessary. More than half of the children screened in a child guidance clinic are registered in the outpatient department for a detailed assessment, which is followed by a diagnostic conference in consultation with child psychiatrists, clinical psychologists and psychiatric social workers working in the clinic and further management planned in accordance with the nature of the presenting problem. The clinic deals with emotional disorders, conduct disorders and neurotic disorders like hysteria, anxiety, phobia and depression in children. In addition, various behaviour disorders associated with neuropsychiatric conditions in brain damaged children resulting from birth trauma, epilepsy, infections and malnutrition are treated with drugs and retraining. Conditions like enuresis (bed wetting) and fecal soiling are also encountered frequently and are managed with behavioural techniques and psychotherapy.

Children with more serious conditions like psychosis, psychosomatic illnesses and disorders of character and personality are admitted with a parent to the residential unit for children attached to the clinic for detailed assessment, intensive care and specialized therapies like group therapy, occupational, art and play therapies and physical treatments. The child psychiatrist contributes to the understanding of the biological and environmental factors which may have brought about the disturbance and which may be influenced to prevent further disability in the child or in others.

The clinic also takes up children referred for scholastic backwardness, provides facilities for psychological assessment to determine intellectual subnormalities and specific learning disabilities and assists in remedial learning programmes. The clinic also undertakes assessment for adoption when such children are referred from institutions like orphanages. To enhance the functioning of child guidance clinic and to promote mental health in the school setting the growing field of school social work adopts many methods and techniques.

*Social Work in School Setting :* Professional social workers play an important role in identification, management and referral of mental health problems of individual and groups of pupils. An effective school social work programme is related to the characteristics of a school's pupils, of a particular school system, the outside community and the social conditions the pupils face.

In the case of 'problem children', the school social worker aims at changing the undesirable behaviour of the children and also at modifying the attitude, knowledge and behaviour of the persons—parents, teachers, and others—who have significant influence on the child's overall performance and healthy personality.

Social case work and group work are the methods by which the social worker helps an individual or group of pupils. Social workers may offer pupils and their family factual information, advice, suggestions or direction. Some times it may be required to interpret school policy and the nature of school authority to pupils.

He works with the administrators, teachers, and special personnel to the end that educational resources are used effectively and pupils are well served. He helps the school administrators to utilise the resources available in the community. He attempts at establishing harmonious relationship between the teachers and pupils.

School social workers act as liaison between home and school, which forms one of their responsibilities. He works with groups of parents to enable them to organize and channel their concerns about their children and the problems of their school system. They may supply information about welfare agencies, they also act as a liaison between the family and community agencies to ensure that service reaches the needy.

Social action model to incorporate mental health component in the existing school system includes the following suggestions :

(a) Depending on the age and maturity, issues like sex education, social and emotional competence can be points for discussion with the children and adolescents.

(b) Conscious efforts of mental health professionals who can organize orientation programmes to sensitize the school teachers to emotional problems amongst children.

(c) Enriching the content of the teachers' training programme with the various aspects of child's mental health and ill-health.

(d) Parent-teachers liaison work to help in exchanging information, modifying perception, sharing with the family and the staff the common problems of children. If mental health professionals are involved in such parent-teachers meetings, many of the problems faced by the children, school and the family can easily be solved. □

# An Experimental Comparison of Different Methods of Teaching High School Biology

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*Success of teaching depends to a large extent on proper method adopted. The present study attempts to explore the relative effectiveness of the traditional method, the demonstration method, and the activity method. The sample consisted of* 60 *secondary school students reading at Bankipore Government Girls' School, Patna. The results showed that activity method is significantly superior to the other two methods under investigation in respect of acquisition of scientific knowledge, application of acquired knowledge and development of scientific skills.*

SCIENCE TEACHNIG in India gained its momentum with the publication of secondary education commission (1953) which recommended teaching of science as a separate stream at higher secondary level after Class VIII like physics, chemistry, biology and mathematics. This decision was negated by the Education Commission (1964-66). The Education Commission recommended compulsory science teaching during the first ten years of schooling. But the recommendations could not receive much attention till 1972. Thereafter the Government of India accepted the recommendations of the Commission and accepted it as the national policy of education. Consequently all the states of the country are now making an attempt for having common ten year schooling pattern in which science has emerged as a compulsory subject.

For the success of teaching science at the secondary stage our science teachers will need guidance and training in the use of effective methodologies of teaching science. In this regard Clerk and Slar (1959) are of the opinion that teaching of science requires great knowledge and skill.

## Purpose

The investigator being an educator of science teachers felt the need of empirically campaigning the effectiveness of different methods of teaching biology at the secondary stage. The three methods namely traditional method, demonstration method and pupil's activity methods were compared. Thus the purpose of the present study was to see the relative effectiveness of the three methods of teaching. Biology, as mentioned above, for which the following hypotheses were proposed to be tested :

(1) There is no difference between Demonstration Method and Pupil's Activity Method in acquiring scientific knowledge.

(2) There is no difference between Demonstration Method and Pupil's Activity Method in the formation of scientific application.

(3) There is no difference between Demon-

stration Method and Pupil's Activity Method in the performance of manipulative skills.

## Method

Among the various methods of teaching biology, some are used by the teacher in schools. Some teachers in good schools use some modern techniques of teaching biology. There is also a dearth of good science teachers (Vanchoo and Sharma 1978). The studies also indicate that Demonstration method and Activity method are two methods known to the teachers in Indian schools. The investigator has based her experimental comparison on these two methods. The investigator selected finally the Bankipur Govt. Girls' School. The students of Class X were selected to participate in the experiments. There were 100 students reading biology in Class X in that school. The students were divided into two sections. From the attendance register it was ascertained that 60 students were more or less regular in their attendance and the rest were very irregular. Hence the experiment could be conducted only on 60 students. The names of these 60 students were written on paper in order of merit (marks obtained by them at the last annual examination) and the list was submitted to the principal of the school for her approval. Having obtained the green signal from the principal the group was divided into three sub groups randomly viz. 1, 4, 7 . . . 2, 5, 8 . . . and 3, 6, 9 . . . In order to ascertain the equivalence of these three groups, the means of the examination marks of the three groups were calculated and it was found that the means did not differ significantly. Thus it was concluded that the three groups were equivalent. Out of these two groups were to be taught by two methods under experiment and the third group was a control group.

A unit from biology was selected for the purpose. On content analysis it was decided that the unit could be taught in five periods. Group A (control group) was left to be taught by the school teacher in the usual way. Group B was taught by the investigator by Demonstration Method for five consecutive days and group C was taught by Activity Method for another five consecutive days.

It may also be noted that the subjects of each group were tested on a standardized test, prepared for the purpose, before the treatment was given. After the end of the treatment all the units of the group were tested on the same test. The scores obtained by them on the initial test gave pre-test scores and the scores obtained by them at the end gave post-test scores. These scores of pre- and post-tests of different groups were arranged area-wise i.e. knowledge, application and skill.

During scoring 1 mark was given for each correct answer. But the total marks for each area under investigation were different. The ranks awarded by the investigator were revised. After revision the marks were summed up methodwise and area-wise.

## Results and Discussion

The next step was to analyse the collected data for arriving at certain conclusions. According to the suggestions of Lindguist, it was decided to employ the technique of analysis of covariance to the data.

1. The results of the computation of analysis of covariance in respect of knowledge is given in Table 5.1.

The obtained value of F in Table 5.1 is 43.79 which is much higher than the Table value of F which is 3.17. This favours the rejection of the hypothesis. In other words, it may be said the three groups taught by three different methods have acquired different levels of knowledge. Identification of the most effective method was done by the help of t test.

**TABLE 5.1**
**Results of the Analysis of Covariance (Knowledge)**

| *Source of variation* | *df* | *Sum of square* | *Mean square* | *F* | *Table value of F at .01 level* |
|---|---|---|---|---|---|
| Between methods (Adjusted for regression) | 2 | 103.32 | 51.67 | | |
| Within methods | 56 | 66.38 | 1.18 | 43.79 | 3.17 |
| Total | 58 | | | | |

The result of the computation of paired t is given below in Table 5.2.

**TABLE 5.2**
**Results of the Computation of Paired t (Knowledge)**

| *Groups* | *Value of paired t* |
|---|---|
| Group A | 0.2 |
| Group B | 5.60 |
| Group C | 7.04 |

The values of paired t, the degree of freedom being the same for all the groups indicate that group C is the best on knowledge scores. It may be concluded that the students taught by Activity approach gained more knowledge than the students taught by other methods. Activity method thus seems to be superior to other two methods.

2. Analysis of covariance was computed for scores on application and the results are given below in Table 5.3.

**TABLE 5.3**
**Results of the Analysis of Covariance (Application)**

| *Source of variation* | *df* | *Sum of square* | *Mean square* | *F* | *Table value of F at .01 level of significance* |
|---|---|---|---|---|---|
| Between methods (Adjusted for regression) | 2 | 167.64 | 83.82 | 85.53 | 3.17 |
| Within methods | 56 | 55.37 | .98 | | |
| Total | 58 | | | | |

The obtained value of F in Table 5.3 is 85.53 which is much higher than the Table value of F (3.17). This is highly significant and favours the rejection of the hypothesis. In other words it may be said that the three groups taught by three different methods are different on application test.

The result of the computation of paired t is given below in Table 5.4.

**TABLE 5.4**
**Results of Computation of Paired t (Application)**

| *Group* | *Value of paired t* |
|---|---|
| Group A | 1.02 |
| Group B | 8.7 |
| Group C | 9.76 |

The value of paired t in Table 5.4 indicates that Group C is the best on application scores. It may be concluded that the pupils taught by Activity Approach are more conversant in applying knowledge when freed with new situation.

3. The results obtained by the analysis of covariance for manipulation are given below in Table 5.5.

**TABLE 5.5**
**Results of Analysis of Covariance (Manipulative skill)**

| *Source of variance* | *df* | *Sum of square* | *Mean square* | *F* | *Table value of F at .01 level of significance* |
|---|---|---|---|---|---|
| Between methods (Adjusted for regression) | 2 | 83.02 | 41.54 | | |
| Within methods | 56 | 35.68 | .99 | 41.8 | 3.17 |
| Total | 58 | | | | |

The obtained value of F in Table 5.5 is 41.8 which is much higher than the Table value of F (3.17). This is highly significant value of F. It favours the rejection of the hypothesis at .01 level of significance. It is, therefore, concluded that the difference in method means could hardly be due to chance. It may be that two methods are equally effective and the high significances value of F resulted only due to the superiority of one method. Paired t test was then applied to the data and the results are given in Table 5.6.

**TABLE 5.6**
**Results of Computation of Paired t (Manupulative skill)**

| *Group* | *Value of paired t* |
|---|---|
| Group A | |
| Group B | 1.0 |
| Group C | 5.2 |
| | 8.37 |

From the analysis given in the Table 5.6 it is evident that pupil's Activity Method is superior to other methods. Teaching by pupil's Activity Method is more effective in acquiring efficacy and accuracy in manipulative skills than other methods.

In conclusion, it may be said with confidence that teaching science by activity approach will yield better results in acquisition of scientific knowledge, application of the acquired knowledge and development of scientific skill.

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# India's "War Plan"

JITENDRA TULI

*Victory was only possible if every body concerned put all they had into the efforts. In fact, everybody at the Central, State and district, even village levels, put in more than they had.*

IT WAS on a hot, blistering June afternoon in 1973 that the "war plan" that eventually spelt victory over smallpox in India was set in motion. Till then the relentless war against an enemy that knew no mercy had not been going on too well. If anything, it had become a general's nightmare. Though there was no dearth of "troops" or "ammunition", the problem was to get them to the right place at the right time. Naturally the causalties were heavy–over 16,000 reported dead and more than five times this number maimed and disabled.

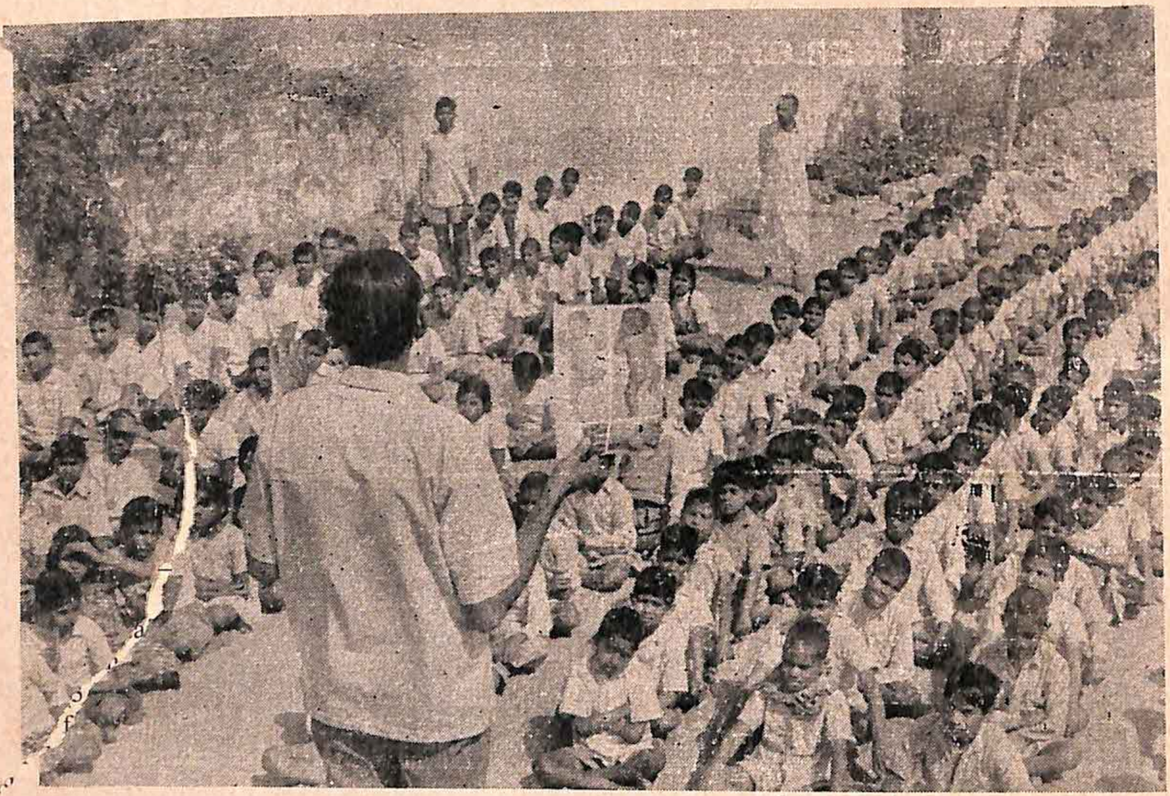
It was a desperate and, obviously something drastic had to be done, and done soon. This dark and desolate scenario was what a small group of officials studied that afternoon in June. Present at the meeting in Nirman Bhawan, the Central headquarters of India's Health Ministry in New Delhi, were representatives from the four most badly affected states, senior officials from the Health Ministry itself and WHO. "We decided then that instead of expending our resources against the entire enemy forces simultaneously, we would concentrate on their strongholds", explains Dr. R. N. Basu, now Assistant Director-General of Health Services, Government of India, who in 1973 was the National Smallpox Eradication Programme Officer. And that was how the "war plan" and final campaign against smallpox was launched.

Recollecting those anxiously hectic days (and nights), Dr. Basu says that the core of the plan consisted of establishing 28 mobile teams, very much like commando units that would strike at "enemy" strongholds at short notice. These teams consisted of one medical officer, one paramedical worker and a driver. Since the available resources were limited, WHO was requested to provide 14 epidemiologists while the Government of India agreed to take care of the rest.

Within three months of this decision, the first mobile teams were already in action in Uttar Pradesh and Bihar, two of the worst affected states, as well as in Madhya Pradesh and West Bengal. These teams were a welcome addition to the over 28,000 "troops" already in the field against smallpox, and the regular health staff in primary health centres all over the country.

Even before the "war plan" and intensive campaign went into action, the country was spending over 80 million rupees (US $ 10 million) annually to combat smallpox. The expenditure, largely on personnel, was equally divided between the Centre and the states. What this meant roughly was that there were three or four vaccinators in each primary health centre, and one vaccinator for 25,000 population in the urban areas.

The biggest bottlenecks were bureaucratic procedures, which hindered mobility, delaying teams from reaching an affected area from another district of state. With the mobile teams in action, this drawback was soon overcome. Thus, in the first week of October 1973, the mobile teams organized visits to every village in the four selected, endemic states.



*'If you see a case like this, tell your teacher'. School children too were recruited to the campaign by visiting members of the mobile teams*

These were reconnaissance trips : having identified the "enemy" areas the troops went into action shortly after. When an active case was found, the entire village was vaccinated and "sealed".

The intensive campaign saw many innovations. Not willing to take any chance, the health workers would insist that nobody from an infected village could go beyond the village precincts, not even to work in the fields. "But how will we eat ?" demanded the villagers. Their fears were allayed by the health teams, which saw to it that nobody went hungry in the village while their vigil was on.

As a result of the campaign between October and December 1973, the number of reported cases went up sharply and cynics were quick to attribute this to the failure of the campaign. But it had been expected by the campaigners, as their aim was to search for smallpox outbreaks and then to contain them.

The results of the search operation only helped to strengthen the government's belief that the campaign not only had to continue but had to be intensified. It was at this juncture that WHO assistance also increased considerably, and the government decided to divert from other programmes to this campaign some of the existing manpower and other resources.

The next six months, until June 1974, were the most crucial, when a systematic, house-to-house search was carried out in all the villages of the vast country. But then victory seemed a distinct possibility, but only if everybody concerned was willing and able to put all they had into the efforts. "And here I must say that everybody at the Central, state and district, even village levels, put in more than they had", adds Dr. Basu.

During the intensified campaign between 1974 and 1977, the Indian Government contributed more than $19 million and the various States and Union Territories another $21 million. During the same period, WHO provided $ 11 million, mainly through a contribution by the Swedish International Development Authority.

As for the lessons learnt, Dr. Basu says that the foremost was that jointly, and with determination, one can achieve goals, whatever the odds. The second was the need to concentrate resources in problem areas, instead of attempting mass, universal coverage. The third "and certainly not the least important lesson" was the realization that "managers" who can take an overview of the situation and tackle it with some innovative solutions were necessary for such programmes.

But the key factors in this most remarkable achievement in the annals of international public health were the determination of the health staff and close collaboration between governments and international organizations and agencies.

COURTESY : WHO

# Minimal Distance Path : A Tip to save Fuel

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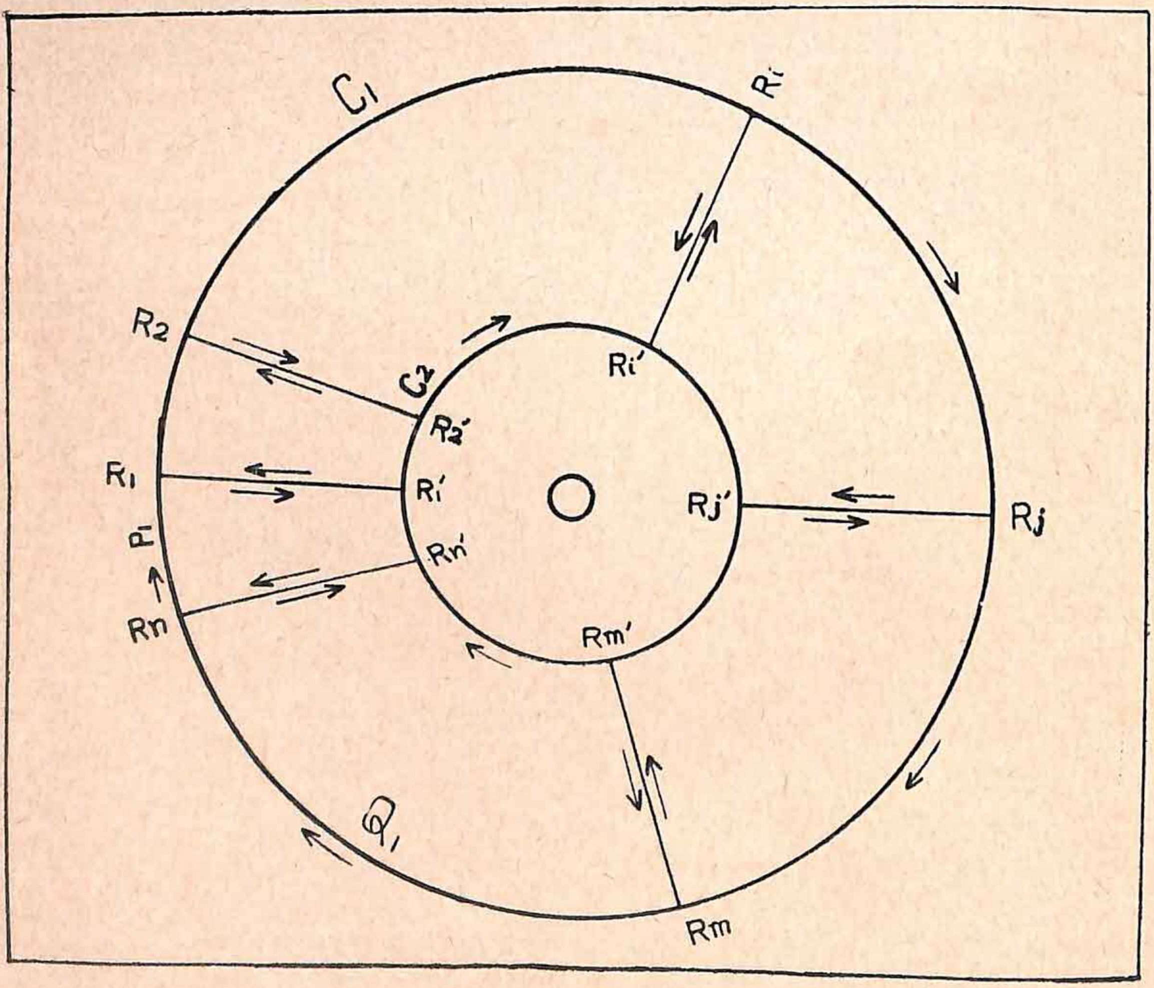
THE TRAFFIC in a busy business centre is regulated by the provision of long Circular Roads coupled with several Radial Roads. The radial roads connect the outer circle to the inner circle. The traffic regulations commonly provide for one-way movement along the inner and the outer circular roads, and two-way movement along the radial roads. However, an arbitrary use of the radial roads may lead to travelling a longer distance for moving from one point to another point on the outer circle. In the present days of severe fuel shortage it is natural to think



of saving fuel by drops. This note provides a tip to the motorist in this direction.

Consider the following configuration :

$C_1$ is the outer circle of Radius R,

$C_2$ is the inner circle of radius r,

O is the common centre;

$R_1R'_1 \ldots\ldots\ldots R_nR'_n$ are the n radial roads connecting the two circular roads along $C_1$ and $C_2$, with $\angle R_iOR_{i+1} = \dfrac{2\Pi}{n}$, $n \geqslant 2$.

While only clockwise flow of traffic is allowed along the two circular roads, the radial roads allow the two-way flow of traffic.

In what follows we shall determine the minimum distance path between two points P and Q on $C_1$.

Without loss of generality we may assume that $R_1R'_1$ is the first radial road that follows P and $R_mR'_m$ is the last radial road that precedes Q, $m \leq n$. (The case $m = n$ will require special attention.)

General reasoning will suggest the exclusion of the use of radial roads not falling within $\overrightarrow{PQ}$. Thus, we have to choose between the two paths:

Path I: $\overrightarrow{PQ}$, and

Path II : $\overrightarrow{PR_i} + \overrightarrow{R_iR'_i} + \overrightarrow{R'_iR'_j} + \overrightarrow{R'_jR_j} + \overrightarrow{R_jQ}$,
$i \leqslant i \leqslant j \leqslant m$.

In case $m = n$ and $\overrightarrow{PR_1} > \overrightarrow{QR_1}$, then $\overrightarrow{PQ}$ is evidently the minimum distance path from P to Q. In any other case, the following consideration will apply.

Total distance travelled under the two paths will be :

Path I : $\overrightarrow{PR_1} + \overrightarrow{R_mQ} + \dfrac{m\text{-}1}{n}\ 2\pi R$,

Path II : $\overrightarrow{PR_1} + \overrightarrow{R_1R_i} + \overrightarrow{R_iR'_i}, + \overrightarrow{R'_iR'_j} + \overrightarrow{R'_jR_j} +$

$\overrightarrow{R\,R_m} + \overrightarrow{R_mQ}$ i.e. $\overrightarrow{PR_1} + \overrightarrow{R_mQ} +$

$$2(R - r) + \frac{(m-1)}{n} 2\pi R - (j - i)\ 2\pi(R - r).$$

Thus, path II will involve shorter distance if

$$2(R - r) < \frac{j-i}{n} 2\pi(R - r)$$

$$\text{Or} \quad (j - i) > \frac{n}{\pi}$$

Finally, path II will involve the minimum distance when j-i is minimum. Thus $i = 1$, $j = m$. Also, the distance along this minimal path can be reduced to its minimum by allowing the minimum permissible value for r. □

# Improving the Ability to draw Sketches in Biology

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BIOLOGY, the study of the living, is that branch of scientific knowledge which can be better acquired with the help of neat and accurate sketches. To understand the subject the students need better skill to draw accurate, neat and labelled diagrams. This not only helps them to understand the subject-matter buts its visual effect helps in lasting retention of the knowledge so an acquired. Drawing direct from a dissection or an object under microscope helps them in concentrated observation rather than superficial seeing.

It is, therefore, very important that the students of biology must be able to draw neat and accurate sketches. It is generally believed that drawing is an art which is God-gifted and not so much can be acquired to improve upon it. But this belief is ill-founded. With better instruction and appropriate guidance, the drawing ability of the students can definitely be improved and with this performance of the students in the subject of biology can also be bettered.

To study these aspects, NCERT in April 1978, assigned the subject Project to Shri R.K. Sharma, Principal, Govt. Boys Senior Secondary School, Bijwasan (Barthal), New Delhi. The first phase of the study was over in January 1979 and follow-up study was taken up in September 1979.

To begin with, in the month of April 1978, a test in biology was given to 80 students of VIII Class of Govt. Boys Senior Secondary School, Bijwasan. Out of this population of 80 students, 15 students each were selected from Class VIII-A and VIII-B on the basis of their performance in this pre-test. Those of VIII-A were treated as Control Group and of VIII-B as Experimental Group. In this pre-test, the mean of the Control Group was found to be 4.6 and that of Experimental Group 4.

The Experimental Group was put under the charge of Shri M.L. Malik, P.G.T. (Drawing) and Shri Rampat Yadav, P.G.T. (Biology) of this School. They guided the students in drawing neat and accurate sketches and labelling them properly. With rigorous training and methodical guidance the performance of the experimental group improved a lot. When both the groups were re-tested in October, 1978, the mean score of the experimental group was found to be 21 and that of control group as 10.7. Some more guidance and training was imparted to the experimental group, whereas the control group continued with normal classroom studies. After another three months, when they were tested again in January 1979, the mean of the experimental group was found to be 24.4, whereas that of control group, it was 12,1.

The data was further analysed satisfactorily with a view to find out if there was any significant difference in the performance of two groups. The Table below gives the mean and standard deviation of the two groups.

| *Group* | *Mean* | *Standard Deviation* |
|---|---|---|
| 1. Control Group | 9.18 | 3.56 |
| 2. Experimental Group | 16.49 | 7.08 |

'T' Value based on $(15+15-2)=28$ degree of freedom was found to be 2.87 at 0.01 level (1 per cent) and table value was 2.76. This was a clear proof that the difference of means of the two groups was quite significant. Thus, our hypothesis, that the ability of the students in the drawing of sketches in biology can be improved by providing better guidance and training and that in turn leads to the better performance of students in biology, is proved to be correct.

In the year 1979-80, a follow-up study was taken in hand to judge if the skill in drawing so developed still persists or it has declined and decayed after a lapse of time. The same population of the students who had by now moved to Class IX, was given test by the *test sheet* previously designed. This time, the sample was reduced to 8 students from each group and they were given three tests at an interval of approximately three months. Their performance is as follows :

| *Test and Date* | *Control Group* | | *Experimental Group* | |
|---|---|---|---|---|
| | *Mean* | *Standard Deviation* | *Mean* | *Standard Deviation* |
| I 13.9.79 | 12.75 | 4.7 | 25.3 | 2.75 |
| II 7.12.79 | 11.25 | 2.9 | 26.5 | 2.70 |
| III 21.3.80 | 13.0 | 2.1 | 25.4 | 2.20 |

This data was again analysed satisfactorily to calculate 't' value of the difference of means of the two groups. In this statistical work Mr. I. R. Sardana, P.G.T. (maths) gave his helping hand. It was found that the actual 't' value based on $(8+8-2)=14$ degree of freedom was 8.500. The table value of 't' based on 14 degree of freedom at 0.01 level (1 per cent) is 2.977 and at 0.05 level (5 per cent) is 2.145.

Since the obtained value of 't' is 8.500 on statistical calculations is much more than the table values at 0.01 and 0.05 levels of significance, it leads to the conclusion that there is a significant difference in the performance of the students belonging to experimental group as compared to control group students.

The logical conclusions based on this experiment are :

(*i*) The drawing ability of the students can be improved by providing them better guidance and methodical training.

(*ii*) The ability to draw neat and accurate sketches in biology does help in better performance of the students in this branch of scientific knowledge. □

# A Goddess defied

ARUN M. CHACKO

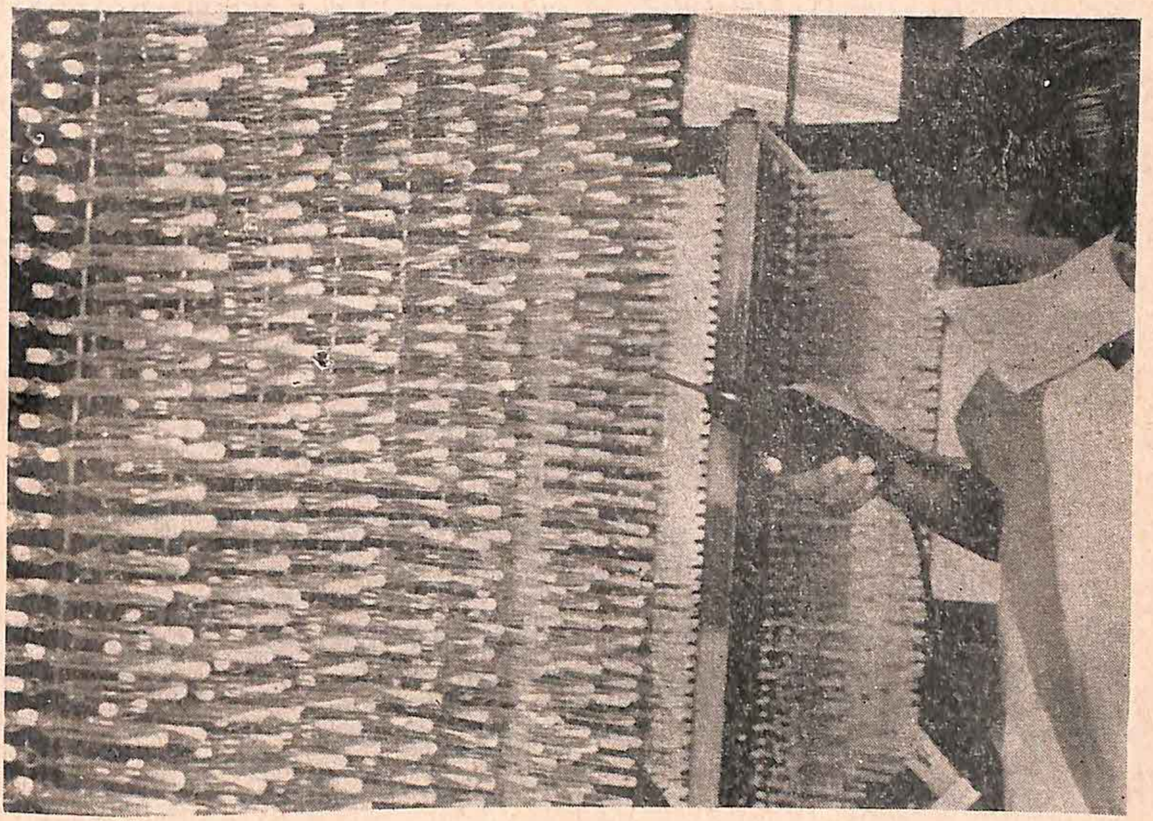
*"Often, before uneducated villagers would agree to submit, the vaccinators would have to jab themselves in front of the entire community, to prove that there was nothing harmful !"*

LATE IN May 1975, at the sleepy little eastern border town of Karimganj, Indian smallpox field workers zeroed in on the railway station and successfully isolated a victim of the disease —Saiban Bibi, aged 30, a woman migrant from Bangladesh. That was the last time any of the several thousand people employed by India's Smallpox Eradication Programme had occasion to use their skills.

It had been far from smooth sailing, and at the outset there was a critical shortage of manpower. Mr. L.R. Tiwari, a former vaccination inspector who spent 20 years combating smallpox, told me : "Before 1960, Delhi with 2.5 millions people had just one vaccination superintendent and 35 vacinators (and the capital has always been more fortunate than the rest of the country). When the smallpox pilot project was started in 1960 staff strength was raised to 37 inspectors and 176 vaccinators. This permitted a door-to-door survey of the entire population and every individual got his or her primary vaccination".

But the primary task was not so much reaching individuals as overcoming ignorance and prejudice. Shitala Mata has for centuries been worshipped as the goddness of smallpox, and temples dedicated to her are dotted around the country. Some devotees believed she spilled grain from a basket on her head every time she shock it, and each grain turned into a smallpox pustule. Victims survived if she used water from the pitcher in one hand to clean the spilt grain, but did not survive if she used the broom which was in the other. Some people worshipped smallpox cases as being blessed by the goddess. Relatives and friends would come miles to pay homage—and merely succeeded in spreading the infection.

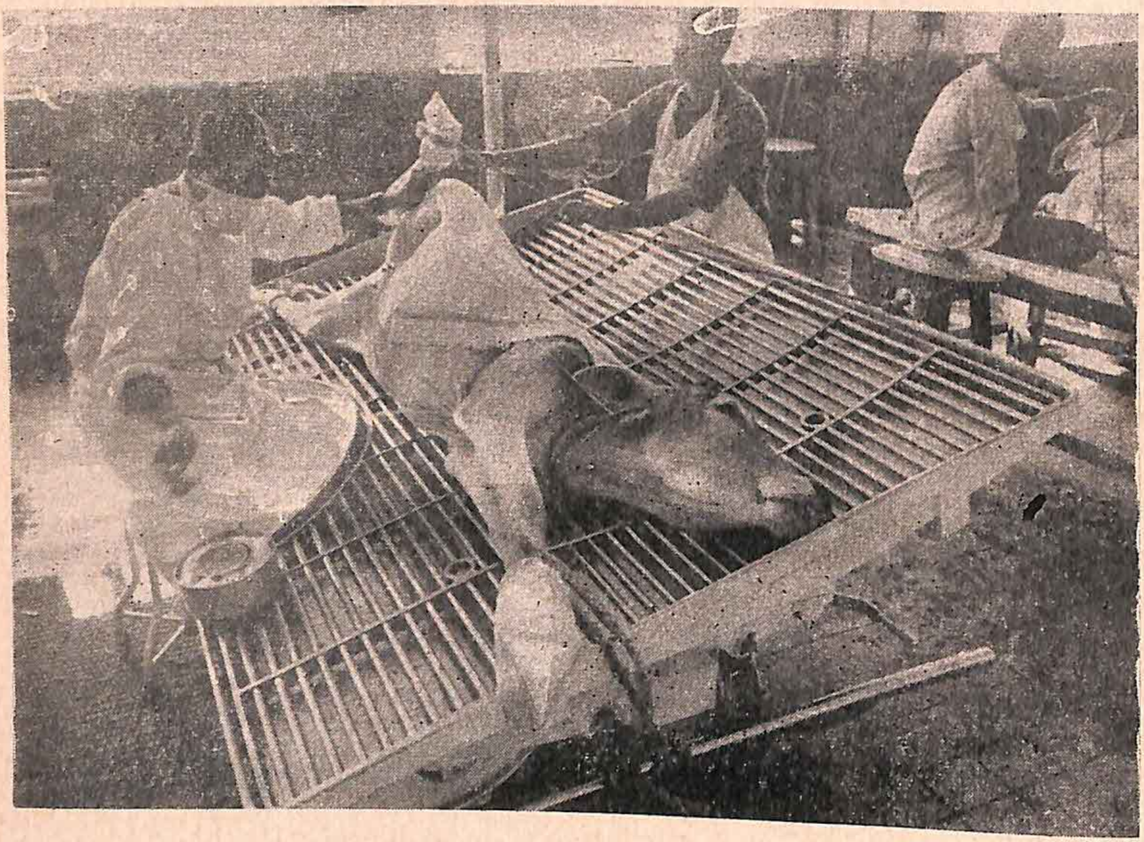
So it was not surprising that many refused to be vaccinated against what was considered to be the goddess's generosity. Another vaccination inspector, Aman Hussain, recalled : "When we first went into the field, people got agitated and soon became violent. The police had to intervene". But that solved few problems.



*The "bullets" that helped to exterminate a killer disease. Serried ranks of freeze-dried vaccine doses in an Indian laboratory*

"The people were agitated about the vaccine, which was believed to come from the cow and was therefore against the Hindu religion", said Mr. C.B. Sharma. "Religious groups like the influential business-oriented Jains and the Namdhari Sikhs even started heated campaigns against it. Villagers claimed that their kids died following vaccinations, and undoubtedly some did. However this was because they would rub cow-dung on the fresh vaccination, thus causing tetanus. Or they would immediately suck out the vaccine. But the blame was invariably put on the vaccinator, who received an extremely hostile reception whenever he returned".

Often the vaccinators would first have to jab themselves in front of the entire community, to prove that there was nothing harmful. Mr. Tiwari himself did not compaign. But the remark : "I had to give myself smallpox vaccinations four to five times a year. And every time it worked. We would persuade freshly vaccinated cases to stand around for 15 minutes so the vaccine would dry, and we warned them of the grave consequences of applying cow-dung. When protected kids didn't die in any of the post-1959 smallpox epidemics, opposition to vaccination faded away. There has been no smallpox in those villages and slums for the last 20 years, even though some devotees to



*Freeze-dried vaccine being prepared from virus grown on the skin of a living animal—a calf*

Shitala Mata began worshipping the inflamed vaccination scab on the eighth day !"

Over the years, conditions and awareness throughout the country underweand a sea-change. Back in 1958 it would take hours to persuate just one man to take his shot. Field workers would travel miles to track down a case, who might be carried from village to village just in order to dodge treatment. "Today when we go into the fields, we're welcomed", Dr. N.K. Gupta, Delhi's Medical Officer for Communicable Diseases, said with evident satisfaction.

Most crucial to eventual success was the new WHO strategy implemented from 1973. Rather than vaccinate every individual—an impossibility with 650 million people—it was decided to concentrate available resources on areas with smallpox cases. Detection was a critical feature, achieved largely through publicity, with the offer to rewards for anyone finding a sufferer, and house-to-house searches for cases of fever with rash.

"We have now started taking immdiate containment measures on the report of any case of infectious disease", Dr. Gupta told me. "Patients are removed by flying squad to the Infectious Diseases Hospital, and their homes and surroundings are immediately disinfected. Anyone who came into contact with the case and those living around are given prophylactic immunization. The area is investigated to find out any source of infection or any additional case. We wait and then try to delimit the area in the event of secondary cases".

In the light of long years of experience in the field combating smallpox, what would the field workers do to contain the menace of infectious diseases ? They unanimously acclaim the measures spelled out by Dr. Gupta—not for the sake of agreeing with a superior, but out of a genuine belief in the superiority of the successful WHO strategy.

COURTESY : WHO

# Innovations in the Teaching of Mathematics in Primary School

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THE TRIBAL children of the North East have been considered to be weak in mathematics. Many of them have even an aversion to or a fear of mathematics. Hence, maths is still an optional subject. However, experience has shown that these children are not less intelligent than others, that their aptitude for learning mathematics is the same as that of any other children in the rest of the country. The reason for their backwardness is that perhaps maths in schools here has not been handled as it should have been keeping in mind the tribal and rural background of the children.

Various attempts have been made during the past ten years to make use of the principles, and to apply these in the teaching of maths to the tribal children. In the process a variety of apparatus has been devised and used in the classrooms with success. The following conclusions have been arrived at from the experience gained in this way :

(1) The mathematical concepts are quickly grasped and fairly well retained when they are learned mainly through the concrete, when learning maths becomes an activity of doing and learning at the same time. Hence the use of the apparatus.

(2) Brightly coloured apparatus seem to yield better results as perhaps they make better and lasting impressions on the young minds.

(3) The tribals of this area, even though illiterate seem to have a unique way of calculating-adding or subtracting. The children seem to have inherited the genius from their parents. From experience we know that quicker learning is possible with the use of Base-Five for calculations.

The exhibits are some of the apparatus used successfully as teaching aids in a few schools. They have been tried out with children beginning from the children of the pre-school age, where the whole body is involved in the learning process, to those of the Class IV age, where the child is initiated into the beginnings of geometry through the concrete. The following are a list of the aids :

(*i*) Floor discs,
(*ii*) Flannel graph discs,
(*iii*) Disc charts for counting,
(*iv*) Deminoes for teaching of numbers and values,
(*v*) Abacus for place value of numbers,
(*vi*) Pocket boards for pattern making,
(*vii*) Geo boards : (*a*) for pattern making for learning the 2 processes of multiplication and division, (*b*) for introduction to shapes-space-area perimeter, graphs,

(*viii*) Attributes for learning the properties of 4 different shapes and the first stage of fractions.

All these aids have been made with the locally available materials. The children of this area are resourceful and dexterous as they are all of them children of farmers who make their own tools. The aids have been made by the students of middle and high schools where such experiments are carried out, as part of their work experience programme.

**Floor Discs**

From experience it has been found that children of pre-school age, can quickly grasp the concept of values of the numbers one to ten, with the aid of this method. Not only, the eye and ear, but the whole body is involved in this learning process.

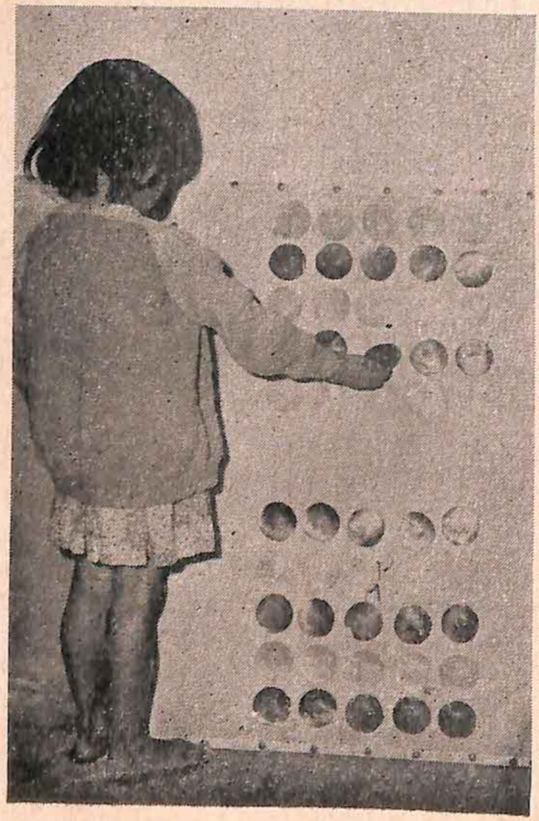
*Method :* Ten cardboard discs of the same colour are arranged on the floor in front of the class. At the start the child stands a little away from disc No. 1—a place denoting 'zero'. The child then steps from one disc to the next. At each disc he stops and calls out the number before proceeding to the next disc. Care should be taken that the steps are taken deliberately with a pause at each, before calling out the respective numbers. From disc No. 5 to disc No. 6 the child does not *step*, but moves with a *jump* using *both feet together*, then proceeds step by step as before until disc No. 10 is reached.

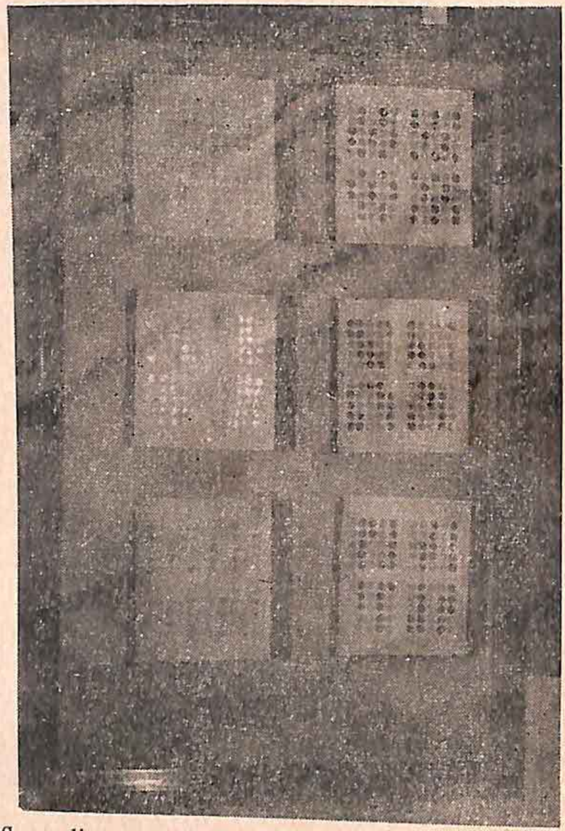
Every child in the class should have at least one turn daily for about two months with this method of counting while the rest of the class is lined up facing the discs—disc No. 1 being placed to the left of the class and No. 10 to the right. It is not advisable to write the numbers 1 to 10 on the discs as this usually stops mental activity and leads to memory learning, not concept forming. The *jump* between discs 5 and 6 leads the child to the concept :

Six is $5+1$; 7 is $5+2$ and so on. These mental concepts are very helpful later on for quick and accurate mental work.

*Testing :* In order to find out whether the children are ready for the next step, the teacher takes his position facing the class with the discs in front of him. The child to be tested, and the rest of the class face the teacher and the discs. The teacher then begins to calls out numbers. If the child proceeds directly to the required disc, there is the likelihood that mental concepts have been formed. If on the contrary the child is not able to identify the disc without counting them all, then it is evident that the child requires more time for the forming of the concepts and should not proceed to the next step.

The learning of numbers upto 100 is a much simpler process if sufficient time is given to this initial stage and the class is not burried through it. Each group of succeeding ten will take about a week. A hundred discs of alternate contrasting colours would be ideal—red and green or red and black—if space permits, 100 floor discs are the best. As a playground activity this method proves enjoyable.





**Flannel Graph Discs**

When floor space is not available for the learning of number 1 to 100 the above method should be used to teach numbers 1 to 30. Once the groupings of tens become familiar to the child, the teacher can switch over to the flannel graph board. Here the discs should be of the same colour as those of the floor discs. This is a good classroom exercise. The discs can be easily removed and replaced; the board itself can be seen by the whole class; there is much movement—of discs as well as of children who have to come forward and remove or replace discs as directed by teacher. It encourages a great deal of concentration, alertness and mental activity. It is also a good testing apparatus, which enables the teacher to judge the progress of individual children.

### Disc Charts

Using the same arrangement of circles, and the same colours, skip counting charts could be introduced in the first year. It would be good to keep the colour scheme the same for the following groups :

- (*a*) groups of tens and fives;
- (*b*) groups of twos; fours; eights;
- (*c*) groups of threes; sixes; nines;
- (*d*) an entirely different colour combiantion for groups of seven.

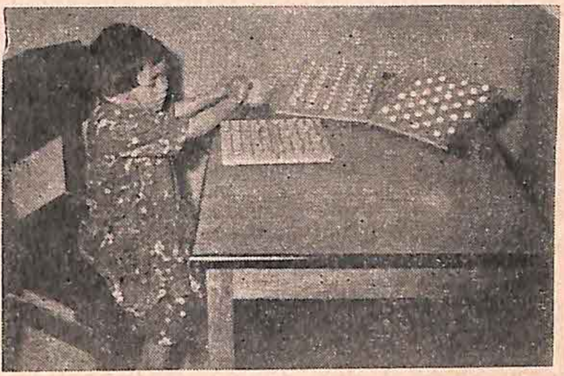
Here again the charts are smaller, the whole mental picture becomes clearer. If the circles are closer with no gap between five and six, (only a dividing line to help) the colour patterns formed by various groupings becomes quite clear and will form clearer mental pictures. This will be of great advantage in future work with multiplication tables and when learning division.

### Individual Disc Charts

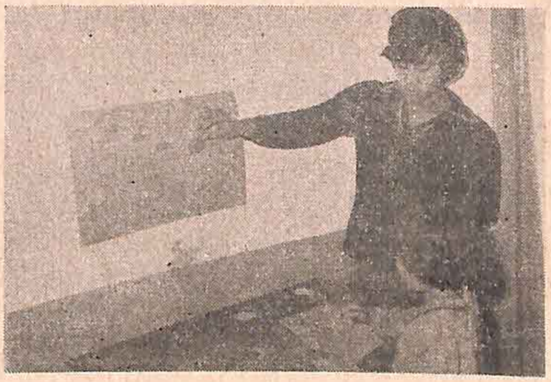
Children are provided with individual disc charts and are asked to colour the circles, numbers being called out by the teacher. Speed and accuracy are what are aimed at. If different colours are used the patterns are clearly depicted. Patterns should be previously prepared by the teacher. Patterns greatly facilitate the teachers correction which can be done at a glance. This exercise makes the children alert to probable patterns that emerge while they are colouring.

### Geo Board

At this stage the geo board could be introduced, to supplement the learning process.



Here again, the moving of coloured beads and the emerging of patterns are two important factors in the process of learning and of fixing the various number groupings. The geo board is a plank of wood 1/2″ thick and 22 cms square. On it are nailed small nails 1/2″ high and 2 cms apart. Across the middle of the board and the down the middle of it are painted lines which take the place of the gap on the disc charts. This line makes for quick calculation.

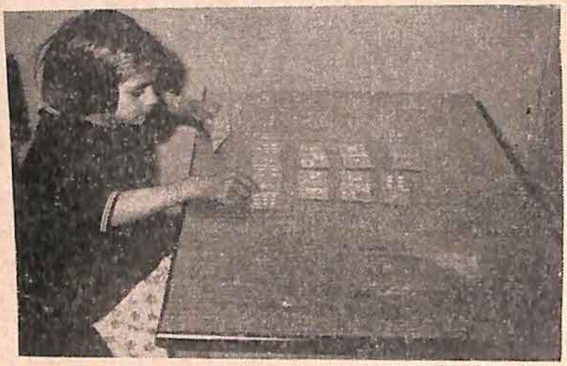


### Pocket Boards

The aim in using these boards is threefold

- (*a*) learning the value of the numbers 1 to 20,
- (*b*) learning the component parts of numbers,
- (*c*) pattern making.

The teacher places his discs on his board and the children copy the patterns on their boards. This helps concentration; careful placing of discs, and selection of colours; latter children are made to discover patterns of their own, given a fixed number. Incidently the children learn the component parts of numbers by using two or more colours when forming their patterns.



**Dominoes**

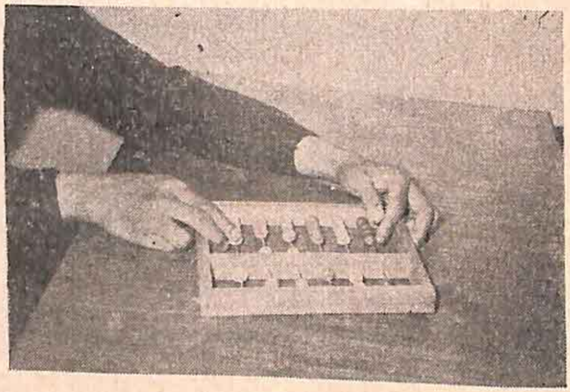
A common game which could be used effectively for testing childrens knowledge of the numbers and their values. Each set consists of eleven cards of plywood, carrying the numbers 1 to 10 and groups of coloured dots. No two sets should be similar. The game begins by placing the card that carries a group of dots and a blank. The child is asked to place the cards in such a way that the number corresponds in the number of dots, until he arrives at a blank card. This game is self-correcting. If the child arrives at the last blank card and still holds cards in his hand, he has probably made a mistake and is asked to shuffle up the cards and start all over again. Since no two sets are alike, this game is a good test of speed and accuracy, if a time limit is given.

**The Decimal Abacus**

This bit of apparatus could be used in the first two years of schooling to teach the place value of numbers upto 1000. A quick and sure means of fixing the place value in the mind of the child is the use of specific colours.

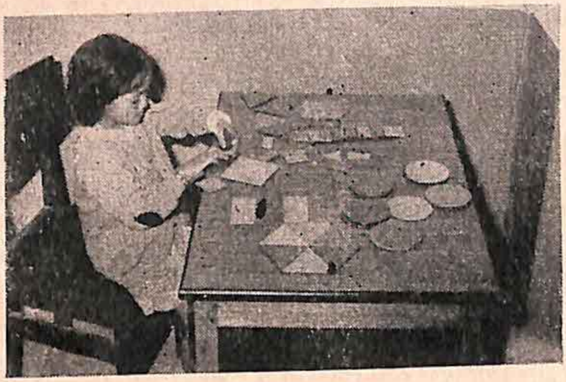
White—for units
light pink—for tens
light green—for hundreds
red—for thousands

The colours chosen are the same as those used in the Australian Quissinaire method.



**The Chinese Abacus**

This apparatus is helpful for calculation up to one lakh. Though it has not yet been introduced into the classroom, individual children have taken to it readily and easily. It seems to fit in with some method of calculation of the locals. The fact that each bead on the top half stands for a group of five, does not pose a difficulty. In fact it facilitates their method of calculation which seems to be in groups of five rather than in tens.



**Attributes**

A set consists of :

(*a*) squares 4″....5 each of the four colours, red, blue, green and yellow
(*b*) squares 2″... do
(*c*) circles 4″ diameter... do
(*d*) circles 2″ diameter... do
(*e*) rectangles 4″ x 2″... do
(*f*) rectangles 2″ x 1″... do
(*g*) triangles 4″ (equilateral)... do
(*h*) triangles 2″ (equilateral)... do

A wealth of concepts can be gained through this set, beginning with the pre-primary stage right upto Class IV :

(*a*) differentiating the four basic colours,
(*b*) discovering 4 different shapes,
(*c*) discovering 2 different sizes,
(*d*) discovering differences in lengths, breadths, angles,
(*e*) first ideas of fractions, quarters, eights, thirds, sixths,
(*f*) pattern making.

**Geo Board—(Geometry)**

Much practice on these boards is essential if children of the primary classes are to move to more abstract forms of thinking in the study of theorems, and the solving of riders. The Geo board besides being an endless source of interest, is a simple and sure way of forming concepts.

(*a*) Being with plotting of points north, south, east, west, with the help of coloured beads.
(*b*) Joining of points with rubber bands forming various kinds of lines, horizontal, vertical, perpendicular.
(*c*) Forming of angles with rubber bands of two colours; one of the arms should be stationery while the other is moved around to form acute, obtuse, right, straight, or reflex angles.
(*d*) The idea of square measure, perimeter, properties of various figures 3 sided,

4 sided or more, can be *discovered* with the help of rubber bands.

(*e*) Plotting of graphs—the x and y axis could be learned with the help of the same rubber bands in the form of various games. In all these forms of learning the stress is on *discovering facts* for themselves.

The above apparatus are designed not to *teach* certain facts but to enable children to *acquire* and *build* up concepts, *discover* facts and above all to bring about a quickening of mental activity. These tribal children are on the whole sluggish in their way of thinking. Their reasoning is very slow, but accurate and steady. One of the reasons could be their home background : there is no colour in their homes—no toys no place for play—they are strapped to their mothers' backs during their most formative and impressive years. Girls have heavy loads laid on their heads from very tender years which perhaps is the reason why they are slower than boys, in thinking.

These learning methods can be introduced by opening creches where the children are exposed to the influences of colour and play things. They are almost incapable of abstract thinking in their early years, but learn very quickly whenever there is concrete to work with. For this, a variety of opportunities should be given them in their early years.

Cubic measure, liquid measure, money and time are some of the topics that have yet to be covered by the experiment. □

# A Victory for all Mankind

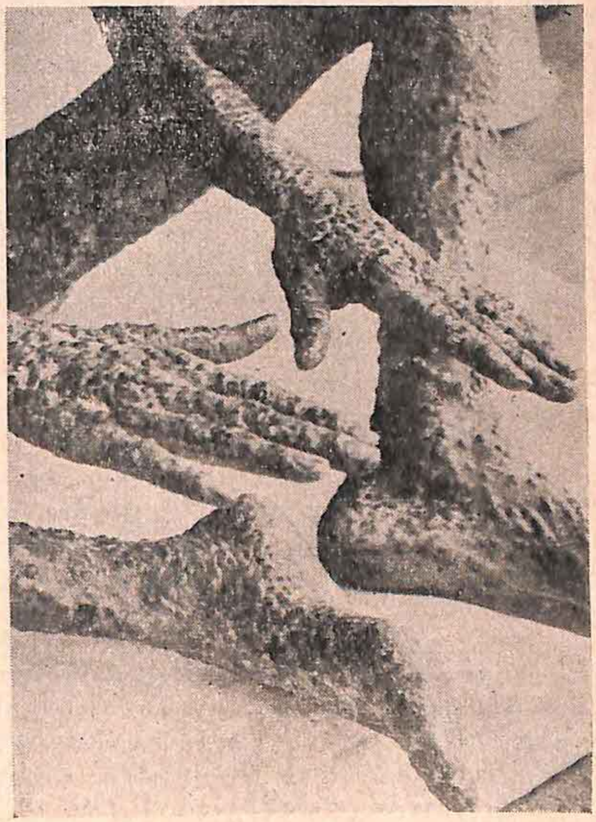
D. A. Henderson

*Brought about by hundreds of thousands of health workers from all over the world, eradication is a triumph of international cooperation and of preventive medicine.*

For centuries, variola virus stalked the world with impunity causing unmeasured suffering, death and blindness. Today it is confined to glass vials kept under high security in six laboratories. To those who vividly recall the suffering of its victims, to health staff who so diligently conducted vaccination programmes, to quarantine inspectors who carefully examined vaccination certificates, it is difficult to believe that "sporadic" cases are not still occurring somewhere. However, convincing data, diligently assembled by tens of thousands of health staff, now demonstrate that smallpox is a disease which can be consigned to history—the first disease ever eradicated by man.

It was little more than two decades ago, in 1958, that the Soviet Union proposed to the Eleventh World Health Assembly that the countries of the world cooperate in a globally coordinated effort to eradicate smallpox. In that year, 63 countries reported 280,000 cases. This is itself a substantial number of cases but, because of incomplete reporting, it would need to be multiplied by 100 or more to describe the true magnitude of the problem. Data regarding deaths are likewise incomplete, but it is reasonable to assume that at least 20 per cent of those infected died and tens of thousands were permanently blinded. There was, and is, no teratment for smallpox; prevention through vaccination was the only way to cope with this disease.

After further study of the Soviet proposal, the assembly in 1959 agreed that a global smallpox eradication programme should be undertaken as a matter of urgency. It was thought that, by "vaccinating or revaccinating 80 per cent of the population within a period of four to five years", smallpox could be eradicated from endemic areas.



*This was smallpox. The world will never again witness the suffering that was caused by the variola virus*

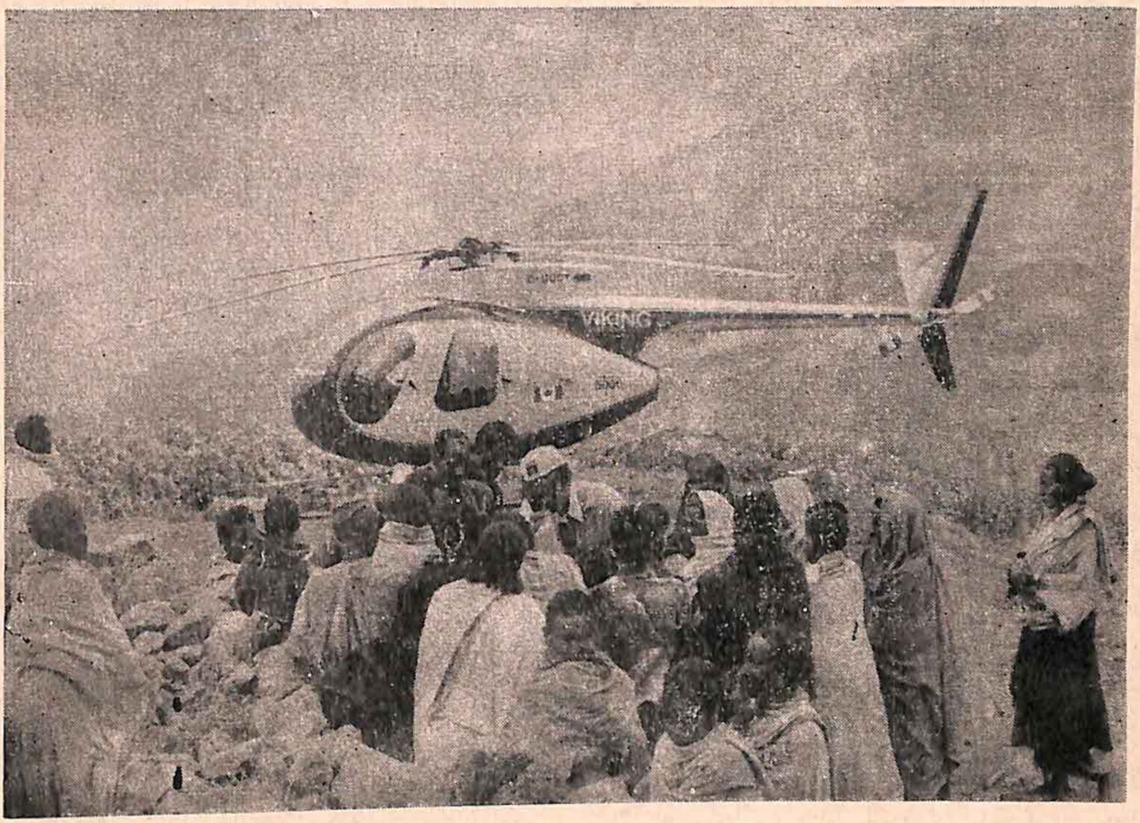
During the following eight years, WHO encouraged governments to undertake programmes, solicited contributions of vaccine, encouraged and coordinated studies of vaccine, strains, and assisted laboratories in starting vaccine production. Many countries started programmes and some succeeded in interrupting transmission. But not all did or could embark on eradication with their own limited resources. Contributions were far less than the funds required and many countries which interrupted transmission were reinfected by their neighbours. Of greater concern was the discovery that, even when vaccinations were administered to 80 per cent of a population, smallpox often persisted. Health authorities became discouraged and pessimistic. It was one thing to eliminate the disease from countries with a developed health infrastructure, but could this be done in the numerous countries, so recently independent, whose limited health services scarcely extended beyond their urban centres? And could these many countries coordinate their efforts sufficiently for smallpox to be eliminated from large geographical areas?

It was a concerned and less confident World Health Assembly which in 1966 decided that WHO should undertake an intensified eradication programme. Approximately US $2.5 million was included in the organization's regular budget to provide for overall programme coordination and for assistance to those countries requiring it. This was a small sum indeed to provide support in some 50 countries with a population of more than one thousand million persons. But it represented almost five per cent of WHO's total budget that year. Hopes were expressed that more substantial voluntary contributions would be made and that all countries would give the programme a high priority. Some delegates optimistically proposed setting a 10 years goal for eradication, but most believed realistically that better control of smallpox was the best that could be expected.

The intensified programme began in January 1967. That year, 46 countries recorded 131,697 cases, a number representing perhaps one per cent of the true number of cases. Four endemic areas were present. A major reservoir was Africa where virtually all countries south of the Sahara were infected. A second important reservoir of smallpox was in Asia, extending from Bangladesh through India, Nepal, Pakistan and Afghanistan. The third was the Indonesian archipelago and the fourth was Brazil, itself comprising half a continent.

Of primary concern as the programme began was the need for sufficient vaccination devices and vaccine—the guns and bullets of the campaign. Large contributions were made initially by the Soviet Union and the USA; eventually 26 countries became contributors. A detailed manual on vaccine production was produced and vaccine production was produced and vaccine batches were routinely tested to ensure that they met international standards. By 1971, all vaccine in use in the programme met accepted standards and by 1973, fully 80 per cent was being produced in the endemic countries, some of which supplied vaccine to others. In 1967, the jet injector was introduced in programmes throughout the countries of western and central Africa and Brazil. In 1968, field studies conducted by WHO showed that the newly developed bifurcated needle could be used to administer vaccine by a new technique—multiple puncture vaccination. The bifurcated needle soon became the standard method for vaccination.

A second concern from the start was the question of an appropriate strategy. Mass vaccination designed to reach 80 or even 100 per cent of a population had succeeded only in some smaller countries and those with more developed health services. For most of the still endemic countries, a different strategy was required. The decision to emphasize surveillance as an important component of the strategy



*The end of smallpox in Asia meant that more resources could be made available in Ethiopia. The net was closing on the last places on earth where the desease lurked*

proved to be the much-needed critical breakthrough. The new strategy called for a systematic two to three year vaccination campaign designed to reach 80 per cent of the population in each country. During this time, it was planned for a nationwide reporting system to be developed which would be sensitive enough to detect such smallpox foci as remained and to eliminate them.

Soon after the programme began, it was discovered first in Nigeria, then in Indonesia and Brazil, that effective reporting systems could be developed in months rather than years. By isolating the patients and vaccinating their contacts, outbreaks could be rapidly contained. Even in areas where vaccination coverage was poor, smallpox transmission could often be stopped quickly. So now increasing, emphasis was placed on the surveillance-containment component of the strategy. Special surveillance teams were recruited and trained. They visited each health unit in an area to ensure that each week it submits a report indicating the number of cases seen. When cases were reported, the teams worked with local health staff to contain the outbreaks, and they visited schools and public places to inquire about rumours of smallpox. A special "WHO Recognition Card" showing a picture of a smallpox patient was printed and distributed to help them in their search.

The first campaigns started in 1967 and, by 1969, all countries except Ethiopia had started eradication programmes. Ethiopia's programme began in 1971. In 20 countries of western and central Africa, a USA-assisted programme of smallpox eradication and measles control succeeded in eliminating smallpox in just three and a half years. Brazil's last case was detected in 1971 and Indonesia's in 1972. By the summer of 1973, smallpox transmission had been interrupted throughout the whole of Africa, except in Ethiopia. That country plus five countries in Asia remained as the only smallpox infected countries.

However, India, Pakistan and Bangladesh, with a population of more than 700 million persons, presented a special problem. Surveillance-containment measures such as had been successful in Africa and South America proved far less effective in these densely populated areas where people travel frequently and far. A different approach was required. During the summer of 1973, Indian health authorities with WHO Staff planned a different surveillance strategy. All health personnel were asked to undertake an intensive search of each village, and later each house, to detect smallpox cases. This would need to be done rapidly to be successful and so the search was planned to be completed during a seven to ten day period. In heavily infected areas this was done each month and, in less infected areas, every second or third month. During the first search in October 1973, thousands of unreported cases were detected. But once discovered, the outbreaks could be contained.

Through careful planning, training and assessment, the searches became increasingly thorough. Between searches, surveillance teams visited schools and markets seeking to learn about cases of smallpox. Containment measures were strengthened. As the numbers began to decrease, a reward for the detection of a case was offered to the first person reporting it and to the health worker investigating it. Similar approaches were soon employed in Bangladesh, Pakistan and Nepal. On 16 October, 1975, only two years after the start of this new strategy, the last case of smallpox occured in Asia—on Bhola Island in Bangladesh. This marked the end of variola major, the severe form of the disease. As 1975 drew to a close, only Ethiopia remained with smallpox. There, variola minor was prevalent, a form of smallpox which killed only one per cent of its victims in contrast to variola major which killed 20 per cent or more.

Ethiopia's programme, besides being the last to begin, faced incredibly difficult problems. Although the country is larger than France and Spain together, the available staff numbered little more that 100 persons. There was almost no health infrastructure. Roads were few and it was estimated that half the population lived more than a day's a day's walk from any accessible road. Civil war and famine compounded the problems. However, with the interruption of smallpox transmission in Asia, more resources could be made available to Ethiopia. Village residents were recruited and trained to serve as surveillance workers and vaccinators; more transport was provided; helicopters were laid on to facilitate supervision. Less than one year later, on 9 August, 1976, the last case occurred there.

Unfortunately, coincident with the last outbreak in Ethiopia, smallpox was introduced into neighbouring Somalia. Before fully effective surveillance systems could be established, nomads disseminated the disease throughout the southern part of the country. In May 1977, a national emergency was declared, additional staff were recruited and special assistance was provided by WHO. An intensive surveillance-containment and vaccination programme continued throughout the summer months. More than 3,000 cases occurred, the last of them on 26 October, 1977.

Nevertheless, surveillance teams and search workers continued for two years and more in their efforts to discover cases. In many countries, a reward was offered and tens of thousands of cases of chickenpox, measles and other rash diseases were reported by villagers in hopes of collecting a reward. Thousands of specimens were taken and sent to WHO Diagnostic Centres in Moscow and Atlanta, USA. None proved to be smallpox. For the disease to persist in a population, it must be passed from one person to another in a continuing chain of infection. Since there is no animal reservoir and no asymptomatic carrier (person having the disease but showing no symptoms), each person who is a link in this chain must experience the characteristic illness. During the programme, it was found that smallpox never persisted for more than eight months in a country without being detected by the surveillance network. Continuing search during a two-year period, that is, three times this eight-month period, provided additional assurance that the spread of smallpox had stopped.

To confirm that transmission had been interrupted, specially constituted WHO International Commissions visited each country. In 1978 the Director-General of WHO appointed a Global Commission to review the experience in all countries. The Commission completed its work on 9 December, 1979, at which time it agreed that there was sufficient documentation to certify worldwide eradication.

The eradication of smallpox means that vaccination everywhere can be stopped and that travellers will no longer need vaccination certificates. The savings throughout the world are estimated to be $ 1,000 million anually. The cost of this achievement was only $ 112 million in international assistance, or $ 9 million spent annually during the 13-year period 1967-1979. This includes all funds spent by WHO plus bilateral and multi-lateral contributions from 42 countries. It is estimated that globally the endemic countries spent perhaps twice this amount but, in fact, few spent much more than they had hitherto been spending on never ending smallpox control programmes.

Now the chapter entitled "smallpox" is closed—let us hope for ever. The achievement of eradication is a victory for hundreds of thousands of health workers in many different countries. WHO staff alone were drawn from 73 different countries. It is a triumph of international cooperation and of preventive medicine. With coordination, cooperation, dedication and imagination it is clear that much can be achieved at minimal cost.

Acknowledgement : World Health

*The President inaugurates the exhibition. The Prime Minister Smt. Indira Gandhi also graced the occasion*

# A visit to Science Fair

KALYAN BANERJEE
*Journals' Cell*
*NCERT*

HUNDREDS of mini-scientists assembled at the Teen Murti House lawns for the National Science Exhibition for Children 1980 on November 14, 1980. While delivering the inaugural address President Shri Neelam Sanjeeva Reddy expressed his happiness over the fact that the theme for this year's exhibition was Science in our Environment. The President said that the public awareness must be created on a top priority basis about preserving the environment through exhibitions or other traditional media. Prime Minister Smt. Indira Gandhi, gracing the occasion as the chief guest, asked children to follow Pandit Jawaharlal Nehru's teaching and face hardship and challenges of life courageously. It was a fair, where science came out from its shell through the tender hands of the children to the open field. The young scientists were eagerly inviting all the problems we have ever had in our mind to give the best solution. The little scientists and technologists were working very seriously in their open-air 'labs'.

At one pavilion I saw a junior 'paper technologist' who was using *water hycinth* (the obnoxious weed found in Indian village) as the raw material. It was surprising that with a simple preparation and meagre investment they could make such a nice hand-made paper. When I asked for a sample they gave me greeting cards made of paper prepared from hycinth pulp.

One 'mining engineer' of Haryana presented a model of 'coal mine'. He explained all about a coal mine. I asked "why have you chosen this project?" Pat came the reply, "Look, it is not possible for everybody to go to Bihar or Bengal to see a coal mine, and hence I took up this project so that interested local students can have some idea".

"With the help of wind you can operate your fan very easily without any electricity". —said a little scientist from Bihar, "will you please tell me why you have selected this project?" He answered, "If one can make use of wind to operate a fan without electricity, is it not good enough?" Another young scientist was demonstrating different steps involved in making a large number of science instruments such as plano convex lens, a spirit lamp or an apparatus which produces hydrogen gas, from fused electric bulbs.

A few children were busy with the "Sagar Samrat" from which unfortunately the crude oil was not coming out properly. I have not seen the original Sagar Samrat, but after watching these anxious little technicians I could easily imagine now about the working coditions of our engineers working in the "High". On being asked "what is the trouble", one of them told me : "you won't get any thing genuine in our country. We have applied some water-proof adhesive to the joints, but see, all the adhesive are just washed away", I peeped into the crowd surrounding the model. Three technicians had lifted the "Sagar Samrat" and were repairing the joints.

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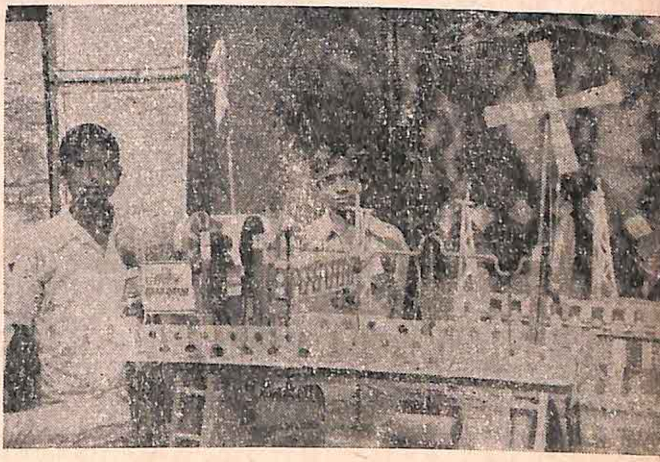
*The present write-up based on a visit to the Teen Murti House, where the author talked to a few participants.

I was very curious about the working model of a tractor. I asked the exhibitor, "It seems to be a very common model, a mere miniature form of a tractor. Why did you select this one to work with?" He replied with a little pride, "Sir, had it been a simple miniature of an ordinary tractor, it would have not been selected at all. The NCERT has published a booklet named "Structure and Working of Science Model, 1980". This model is the very first model described in that booklet. Thereafter, that little 'agro-engineer' added: "The beds are automatically made at the time of sowing with the help of this device". On Being asked, how he has developed the idea, he replied, that he got the idea from the piston of a steam engine. He added further that the farmers spend a lot of time preparing beds. This device helps a farmer to save his time and labour, for a little additional investment.

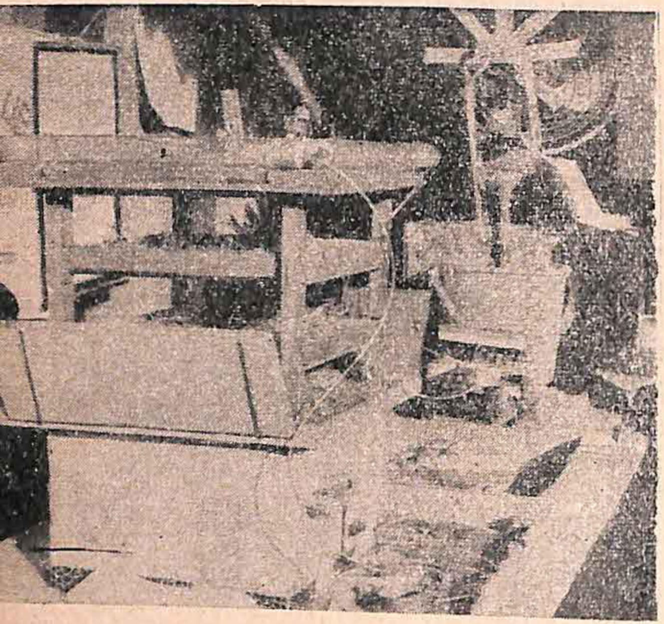
I met another 'agro-engineer' with an exhibit of the functioning of a wind-pump made of bamboo. The mechanism of this wind-pump was very simple. It was made at a nominal cost and with easily available raw materials. "I believe that with a little investment our farmers can have their own wind-pump sets"—said the boy with pride. On being asked "How have you developed your idea", he replied : "seeing a windmill in a TV programme, Sir". We, the adults often see many things but have we ever thought of doing something for our farmers? Watching efforts of these children to help our farmers was a heart-warming experience.

Chicken incubator—a small incubator for hatching eggs was exhibited by a small scientist from Mizoram. It was a simple wooden

*Sugarcane disease and its prevention : A discussion at the pavilion*



*Two junior technologists with their 'generator' : An angwer to the load-shedding?*



box with three electric bulbs and some electric coils. One side of the box was made of glass so that one could see through.

A girl of Rajasthan came to the exhibition with a little family of silk worm. She told me "With a little care we can commercially produce silk even in the climates of Rajasthan". Then she explained the complete life-cycle of the silkworm and operation of sericulture.

Three young-paper technologists presented their project of preparing board from bagasse. They explained how much of bleaching agent is to be added to the pulp, for how many days the bagasse is to be kept in water, the exact timing for drying and what colours are to be added to obtain quality, all within a few minutes.

← *Terrace guardening with reflected sun ray: An exhibit*

↓ *Too many questions at the information cell*

*One of the exhibits that drew a large number of visitors was the 'three-dimensional picture' displayed in the NCERT pavilion. This issue includes one article on the simple technique of 'three-dimentional photography'*

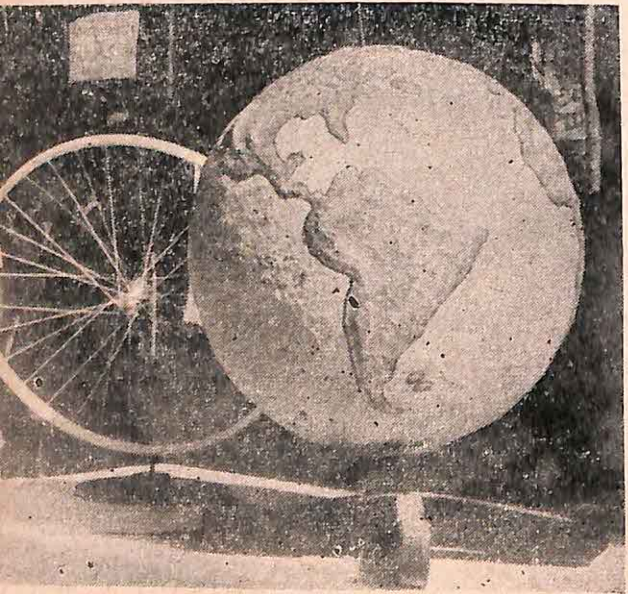
The hand-made paper was so good that I could not resist the temptation of collecting a few pieces for preparing greeting cards.

I never knew that sugar-cane can be affected by so many diseases. Showing some of the diseased sugar-cane one small agriculturist of Andhra Pradesh explained to me how the productivity of sugar-cane is affected by diseases. He also suggested some easy remedies.

One smart boy told that he had noticed how quickly the blades of fans become dirty in the air and on this observation he got the idea of preparing the model of detecting air-pollution. It was a U shaped iron rod connected with a motor. If you apply some petroleum jelly on this rod and rotate in the open air, this rod would collect some dirt. One could find the particles of dust under a microscope. By this method you can ascertain pollution in the environment. Inno-

*A curious visitor at the exhibition*

*The magazines on science and mathematics ↑ at the NCERT pavilion*



*Movement of the Planet earth : An exhibit*

*A display of NCERT publications*

cently I aksed: "Why petroleum jelly, why not something else?" He replied "this jelly is used just because of its $\mu$ (mue), that is, the refractive index of the glass under which the accumulated dusts are to be placed, has got about the same $\mu$ (mue) as that of petroleum jelly". I wanted to know 'What is $\mu$ (mue), Sir?' He took only a few minutes to teach me the theory of reflection and refraction, the velocity of light, the medium of light and then refractive index. While he was teaching me I was reminded of one unmindful student of Class X who always used to think of everything except physics in his physics class.

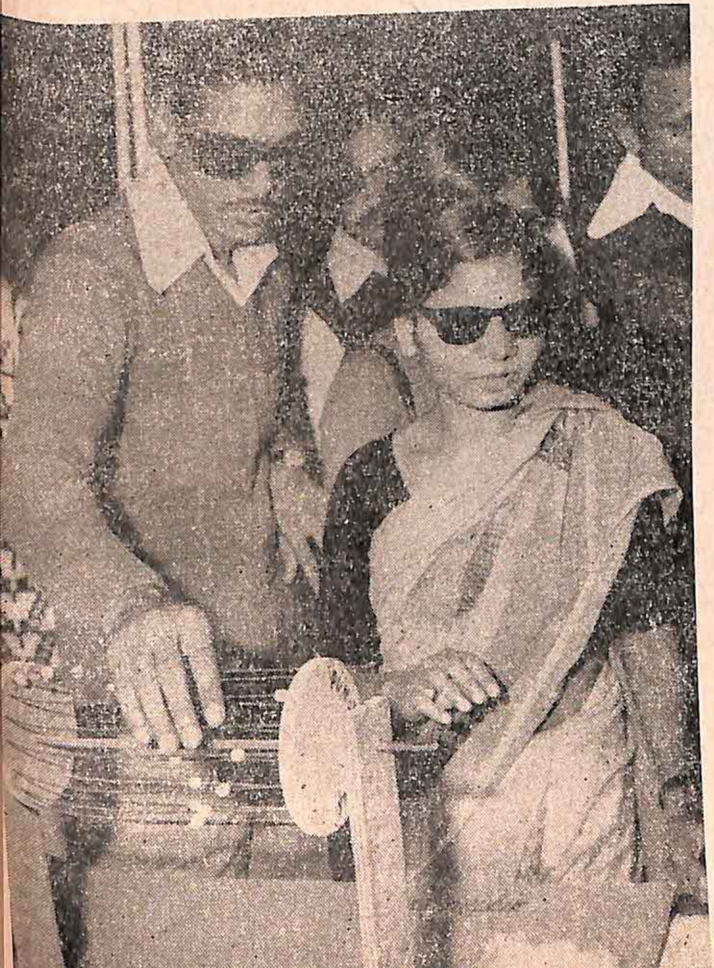
A little lady scientist was exhibiting a dialysing instrument. She explained about the composition of blood, the function of kidney, the accumulation of toxic substances and dialysis. To prepare this model of a dialyser she had not taken much time probably, a lot of time had been spent on framing her idea.

"Sun rays can be used to produce two liters of distilled water per day. The process involves no technological complication. You can have this solar distillation plant at your home, investing nothing",—said one 'solar energy specialist' of Himachal Pradesh. With great efficiency he opened his small solar distillation plant to show all the parts. It was a wooden box having two compartments. One chamber for muddy water which was painted black, to make it a good absorber of heat. There were three holes also on the front wall through which one can get distilled water. To prepare that model, two gifts of nature were blended—one is of course sun ray, another is intelligence.

How much energy do you spend while cycling? Have you ever measured? A young scientist from Tamil Nadu had presented the process of measuring energy output during cycling.

One little solar energy technologist of Orissa had added the solar heat to prepare puffed rice with his device and his adopted process. He showed how the quantity and quality of puffed rice produced can be increased to a great extent by adopting his method.

*Light in the life of visually disalded*



*An exhibit demonstrating the action and reaction*

"Spending a negligible amount of money you can obtain a clay pipe-making machine. This machine consists of an iron pipe, one wooden axle and few wooden supports", told the child technician from Haryana. He added, "unemployed persons can earn a lot by preparing clay-pipes. These pipes are useful for domestic and agricultural purpose—specially in villages.

Number of visitors being very large and time at my disposal was short, I could not talk personally to all the participants. The participants were sorrounded by hundreds of curious visitors. The entire exhibition ground wore a festive look. However, I noticed some of the models were being repeated frequently.

A national level exhibition organized by experienced people should have displayed models having good finishing. I wanted to know, if the little exhibitor or the science teachers are familiar with the science journal—School Science—published by the NCERT. I was surprised to learn that hardly a few science teachers or the children present there, heard of the School Science. For this state of affairs one is not sure whom to blame, but blamishes apart, it was a rewarding experience for me to know what the young scientists are doing and making. ☐

# Nobel Prizes in Science—1980

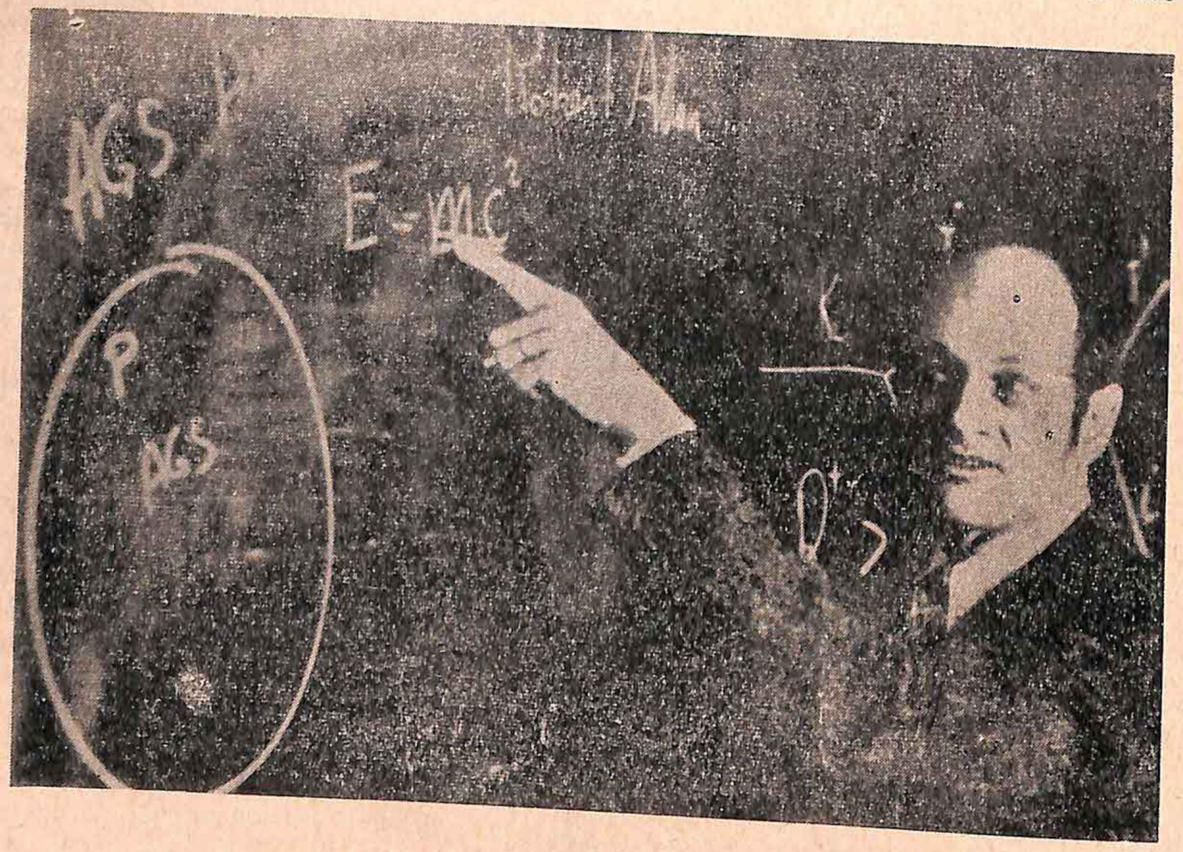
THE NOBEL Prize in Physics was awarded jointly to James W. Cronin of the University of Chicago and Val. L. Fitch of Princeton University for fundamental research in the nature of matter and anti-matter.

Physicists Cronin and Fitch were cited by the Swedish Royal Academy of Sciences for "their discovery of violations of fundamental symmetry principles in the decay of neutral K-mesons". Hitherto scientists thought that all the laws of nature applied equally to matter as to anti-matter. Cronin and Fitch discovered this was not true, that in the decay of the K-Meson, a nuclear particle, for example, nature "played favourites", favouring matter over anti-matter.

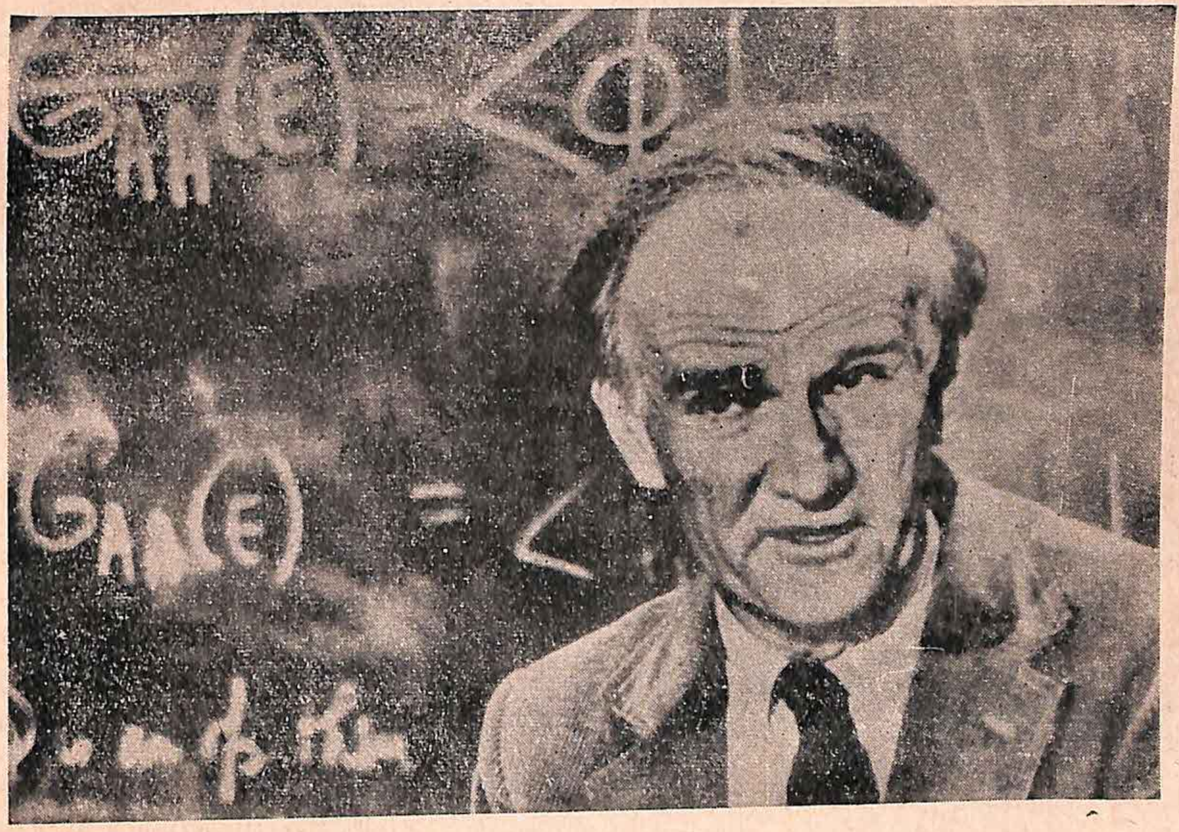
According to the "Big Bang" theory of the creation, the universe began with an explosion of a giant ball of matter that sent particles flying in all directions. If the laws of physics were symmetrical, equal amounts of matter and anti-matter would have been made. But instead, within seconds of the big bang an excess of matter resulted, which is now the physical universe—the stars, planets and people as we know it.

The academy said that this discovery had "great importance for the understanding of elementary matter and life of earth".

The chemistry prize was awarded to two



*James Cronin*



*Val Fitch*

Americans and one British for their research in Nucleic acids, the substance making up the genes that govern the chemical machinery of all cells.

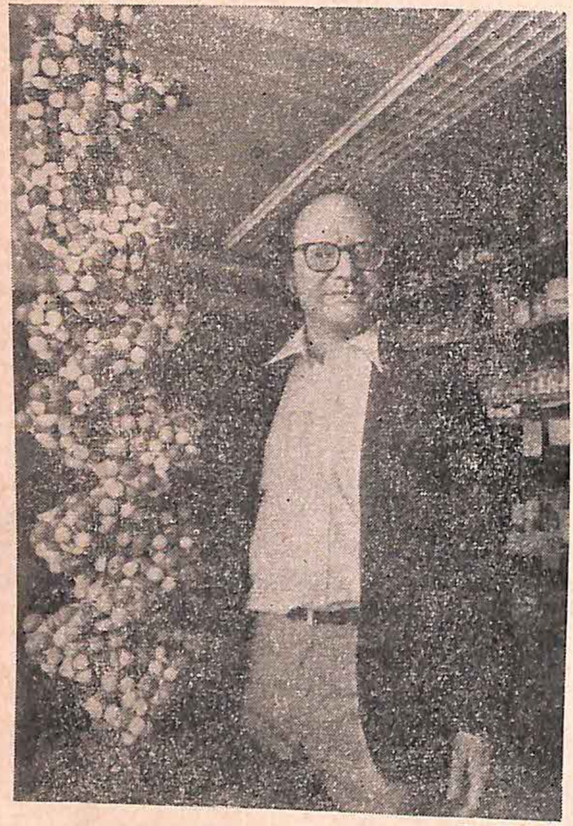
Professor Paul Berg of Stanford University received one-half of the 212,000 dollar chemistry prize. Professor Walter Gilbert of Harvard University shares the other half of the award money with Professor Frederick Sanger of Cambridge University, England.

The three scientists winning the Nobel Prize in chemistry all contributed significantly to the understanding of DNA, the deoxyribonucleic acid molecule that is shaped as a double helix and carries the genetic codes that govern the activity of all cells.

Berg is considered the "Father of Genetic Engineering", or "Gene Splicing", in which segments of the double helix chain—genes—are broken up and recombined, allowing scientists to study the behavior of the specific gene. Berg was the first to construct a molecule containing parts of DNA from different species.

Sanger and Gilbert were cited for their work in determining the exact sequences of the chemicals—Adenine, Guanine, Cytosine, and Thymine—on the DNA molecule. The sequence determines which amino acids are made. The sequence has been called the "Alphabet" of heredity.

The Academy said that' 'The investigations of Berg, Gilbert and Sanger have given us a



*Paul Berg*

detailed insight into the chemical basis of the genetic machinery in living organisms. They have already formed the foundation for important technical applications. In an extended perspective, they will certainly play a decisive role in our efforts to understand the nature of cancer, as in this disease there is a malfunction in the control of genetic material and the growth and division of cells".

By understanding how the genes instruct cells to function, scientists can better understand what happens when improper instructions result in disease and by isolating genes responsible for the production of specific substances such as insulin, scientists can manufacture them in large quantities. Recently, scientist isolated the genetic instructions for the production of interferon, a substance produced by the body to fight viruses and perhaps cancer.

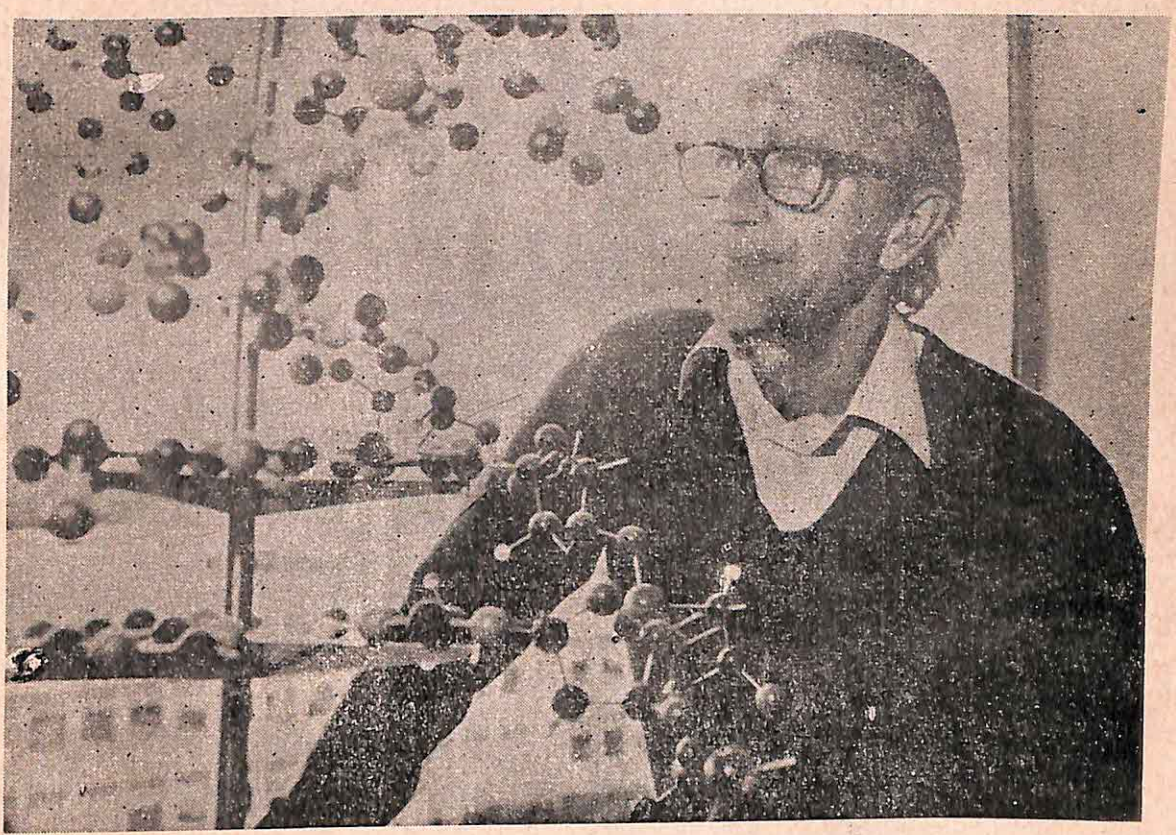
Berg has been Professor at Stanford University since 1959. Gilbert has been a Professor in Molecular Biology at Harvard since 1968.

This year's prize was the second for 62-year-old Frederick Sanger. He also won the prize in 1958 for his work on the chemical code of proteins specially insulin. He thus joins a coveted band of double Nobel Prize winners which includes people such as Madame Curie.

Dr. Sanger, who is married with two sons and a daughter, has been engaged on chemical research at Cambridge since he graduated here at St. John's College in 1939.

In 1951 he joined the staff of the U.K. Medical Research Council and later became head of

*Walter Gilbert*



*Frederick Sanger*

the division of protein chemistry in the Council's laboratory of molecular biology.

He completed an analytical study of the chemical structure of insulin in 1955 and became the first chemist to determine the complete chemical structure of any protein.

After his 1958 Nobel award he went on to study the structure of other proteins, including various enzymes, and studied the relationship of biological activity of chemical structures.

Dr. Sanger said that he had been moving away from research into proteins like insulin over the last 5 to 10 years. His interest now centred on the chemical structure of genes and the method of decoding nature's "instruction" for building up organisms.

The doctor says better knowledge in these fields could lead to a better understanding of what causes disease. "If we can understand that, then we can try to do something about it", he adds. Dr. Sanger realises, however, that this work will involve so much research that it is unlikely he will be able to complete the work in his lifetime.

Two American and French scientists who shared this year's Nobel Prize in medicine offer a classic example of how basic research leads to practical applications in fighting human disease.

The 1980 Nobel Prize in medicine was awarded to two US citizens and a Frenchman for their individual contributions in the field of immunology.

Baruj Benacerraf of Harvard University,

*George Snell*

George Snell of the Jackson Laboratory in Bar Harbor, Maine, and Jean Dausset of the Saint Louis Hospital at the University of Paris were cited for their work on "genetically determined structures on the cell surface that regulate immunological reactions".

Benacerraf, who is 59, was born in Caracas, Venezuela. He received some of his early education in Paris and his university training at Columbia University in New York and the Medical College of Virginia. He became a US citizen in 1943.

Benacerraf has done medical research at Columbia University Medical School, at the Hospital Eroussaid in Paris, at New York University Medical School, at the National Institutes of Health near Washington and at Harvard, where he has been chairman of the Pathology Department of the Medical School since 1970. He also recently became president of the Sydney Farber Cancer Institute in Boston —one of 21 federally designated cancer centers in the United States.

Snell is 77 and was born in Haverhill, Massachusetts. He attended Dartmouth College and received his doctorate in genetics from Harvard in 1930. He began working at the Jackson Laboratory in Bar Harbor, Maine in 1935 and remained there until he retired three years ago. He was elected to the U.S. National Academy of Sciences in 1970, to the French Academy of Sciences in 1978, and was awarded the Gregor Mendel Medal of the Czechoslovak Academy of Sciences in 1967.

Snell began his pioneering work in 1942. "It was basic research", Snell said in an interview. "It did not come suddenly". We worked away for many years building up data-information. And many wonderful people worked with me.

"We knew there were genes that in some way determined whether or not an individual would accept or reject an organ or skin transplant—how the body recognizes 'self' from 'non-self'. I wanted to develop a method to investigate how this system works". Snell's method involved in breeding mice and transplanting tissue, thereby isolating certain characteristics—genes—to determine what they did and how.

"Among these genes was one that stuck out like a sore thumb and played a more important role than the others in determining whether or not a tissue graft would be rejected or accepted", Snell said.

Later, Dausset found in man a "Gene that showed a remarkable similarity to this mouse gene", Snell said.

Snell coined the phrase, "Histo-compatibility complex" for the group of genes that determines whether or not tissue from one mouse is compatible with tissue from another.

The "Histo-compatibility complex", or group of genes responsible for rejection or acceptance of foreign tissue, also plays a role in immunology—the body's ability to fight off a foreign substance or disease such as a virus or bacteria.

Benacerraf established that the ability of an individual to fight off foreign agents such as viruses was under hereditary control. This he did by studying the ability of Guinea pigs to resist a synthetic substance he made in the laboratory.

By breeding the animals, he found a single dominant gene that controlled the ability of the animal to attack this foreign substance. This gene, the immune-response gene, is inherited, explained Dr. Ronald Germaine, a former student and now a colleague of Benacerraf.

The most important of the "immunity genes" studied by Benacerraf are part of the "Histo-compatibility complex, has become the focus of research on how the body fights disease.

When an invader bacteria, virus or foreign tissue enters the body, the gene participates by permitting the white blood cells (lymphocytes) to do two things. First the gene produces a substance that becomes part of the invading cell's surface structure, thereby "marking it" for attack by the white blood cells. This makes the invading cells differ from the another structurally. It is known how structurally they differ. The question now is, how do the white cells responsible for destroying them recognize this difference in cell structure?

The second role of the gene is to allow cell-to-cell communication between the various types of white blood cells, which do different jobs in destroying the invader. Without this cell-to-cell communication, the white blood cells would wander about aimlessly, not working together.

By identifying genes responsible for giving instructions to fight disease, scientists hope "to learn how to manipulate the human antibody system", Benacerraf said in a press conference in Boston. Studying this question is what he intends to do with his share of the prize money, he said.

*Baruf Benacerraf*

"Then we can apply what we learn about what makes healthy individuals healthy to help those not-so-lucky individuals build up immunities to become healthy, too. There is no greater challenge than to train young scientists to dedicate themselves to making this a better world", Benacerraf said.

Dausset applied Snell's tissue transplant work with mice to human tissue. This subsequently led to "tissue typing", similar to "blood typing", to see if, for example, kidney tissue of a donor will be accepted by the tissue of the recipient. This greatly increases the chances of a successful organ transplant.

*Courtesy* : USICA & British High Commission

# Modern Research Shows How a Sea Vanished

*Data on how that unique river, the Nile, came into being, and on the checkered history of the Mediterranean basin, were an interesting fall-out from the coastal erosion studies undertaken since 1971 by Egyptian specialists with assistance from Unesco and UNDP.*

*Dr. Evald Nielsen, a civil engineer from Denmark who was Unesco's chief technical adviser on the project, described some of the findings.*

THE HISTORY of the river Nile goes back at least 10 million years. Under its delta there are sediments about five kilometres thick built up over those 10 million years. Most of them actually come from the Red Sea mountains. Only in the last one to two million years have there been sediments from Ethiopia and Central Africa, and these have predominated only in the last few hundred thousand years. And it is only in the last 10,000 years that the character of the Nile has been as it is today, or as it was until 1965. Before that time there was much more rain over Egypt.

*But now that none of the water comes from the mountains near the Red Sea and from Egyptian territory, where does it come from?*

Most of the Nile waters come from Ethiopia and about 25 per cent from Central Africa, through Lake Victoria. For millions of years rain has been caught in the highlands of Ethiopia and Central Africa. Scientists are still studying what happened to all this water. It has been suggested that at one period the water escaped to the Red Sea. But from the geology of Egypt we also know that 30 to 60 million years ago there was a very much larger delta between Alexandria and Libya. Waters from Central Africa and Ethiopia flowed northwards into this big embayment, the remains of which are to be found under the desert.

*So much for the water above ground. But there are also large reserves of fresh water beneath the surface, under the deserts of Egypt and the Sudan.*

Most of this water comes from Central Africa flowing down in water-carrying layers of sandstone several kilometres thick and accumulating in subterranean reservoirs deep under the desert. It could be pumped up and this is being done to some extent, but it is a rather expensive operation.

*In the Western Desert, between Alexandria and the Libyan border, there is the huge depression of Qattara. How is it that some of the underground water has not filled it?*

The groundwater is several hundred metres beneath the surface and there are thick impermeable layers above it, so it cannot rise to the surface.

But while on the subject of the Qattara depression, there is an interesting development there. Plans are being drawn up to let water from the Mediterranean into the depression which reaches 140 metres below sea level. The primary purpose of this scheme is to generate power by making use of the difference in water level between the Mediterranean and the large lake that would form in the desert. However, the evaporation of water from the lake could affect the micro-climate in the surrounding desert by bringing moisture to these areas.

*If evaporation can take place on the scale of a lake, causing a change in climate, why doesn't it also occur on the scale of the Mediterranean?*

It also happens in the Mediterranean. Rainfall along Egypt's Mediterranean coast is about 150 mm per year, whereas in Cairo it is only about 25 mm, and upriver at Aswan it is practically nil. So there is moisture and some fertility due to this moisture all along the coast.

Every year, about one and a half metres of water evaporate from the Mediterranean. This is replenished by an inflow of water from the rivers and the Black Sea, but mostly from the Atlantic Ocean through the Straits of Gibraltar. This water carries a great deal of salt which has to be eliminated. Nature takes care of this by allowing water to flow out again through the straits. But the balance is an inflow, so that the Mediterranean maintains a stable water and salinity level.

*But what if some natural—or unnatural—catastrophe were to block the Straits of Gibralter?*

This actually happened between five and ten million years ago. At that time land was continuous from Spain to North Africa and, consequently, there was no inflow, with the result that practically all the water in the Mediterranean evaporated. The area became a desert. Sediments belonging to this desert are to be found today at depths of 3 to 5 kilometres under the Mediterranean floor.

*And what made it change back from a desert to a sea?*

Because of tectonic changes, the Straits of Gibraltar slowly opened up again and the waters flowed in. Of course this took several hundred thousand years, but gradually the Mediterranean assumed its present condition. However it is interesting to note that there were periods lasting some thousand years when the Mediterranean water did not circulate but remained stagnant. We have found organic deposits that testify to this.

*And what about the straits at the other end of the Mediterranean?*

The Black Sea has also played an important role in the history of the Mediterranean. Geologically speaking, it is a young sea, and the Straits of the Bosphorus and Dardanelles which lead to it are actually erosional trenches, scooped out by relatively fresh water escaping from the Black Sea. This water from the rivers flowing into the Black Sea now passes into the Mediterranean, replenishing some of the water that disappears through evaporation. It is a similar mechanism to the phenomenon at Gibraltar : relatively fresh water flows in and the more saline water flows back. But the balance is always on the side of the fresher water.

UNESCO FEATURES

**Students' Corner**

**Project**

# More Strange Pets

SHAKUNTALA BHATTACHARYA
*DESM, NCERT, New Delhi*

IN OUR March 1980 issue, we had talked of keeping earthworm and cockroaches as pets. This time we will tell you how to keep one more common small household insect, the ants, as pets. Their habits make very interesting study. The simplest method to keep ants for a short period is in a large wide mouthed glass jar. Pour moist earth; but not wet, into the glass jar until it is about two thirds full. Locate some ants in the garden, or under a stone, or in a flower pot. Take a large spoon or small trowel to put some ants into the jar. If possible include some pupae, little white or cream egg shaped bodies, popularly known as "ants eggs". Spread a little sugar and a few pieces of sweet fruits such as banana on top of the soil. Cover the top of the jar with fine muslin and fasten with string or rubber bands. Wrap black or dark paper around the jar and keep it in this position with cellotape or rubber bands.

Set the jar aside, and do not disturb the contents for a few days. Then remove the dark wrapping and observe the tunnels made by the ants. Where is the food that was put on the surface? What did the ants do with the pupae? Put a drop of jaggery or jam on top of the soil and watch the ants feed. To watch the ants, with the muslin cover removed you should place the jar on a tray of water.

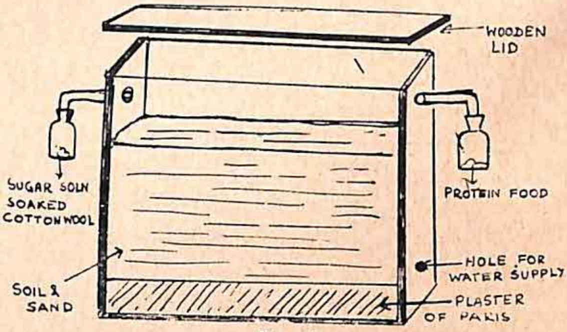


*Fig. 1*

A home for ants can also be made from two pieces of glass and a framework of wood (Fig. 1) The frame should have a narrow (about 5 cm) space between the glasses. The base is filled with plaster of Paris. The top is covered with a wooden lid. Three holes are drilled in the sides, two are connected by means of plastic tubing to feeding jars, one containing sugar syrup or similar substances and the other a source of protein.

The space above the plaster of Paris is filled with moist soil and sand. Ants are introduced through the top and the lid is put on to prevent their escape. It should however be loose enough to allow aeration. Alternatively two holes may be drilled in the lid and plugged with cotton wool to act as ventilators.

A third method of building a simple rest which is portable is to make one with two chambers. An ants nest which consists of two chambers, one for feeding, and the other for brood, each 10 cm$^2$ with a passage between

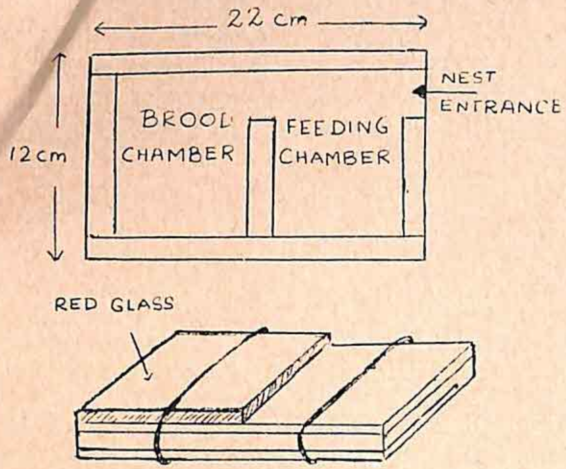


*Fig. 2*

is easy to build. Use two panes of glass approximately 22cm × 12cm.

The partitions are made of 0.6 cm thick glass stuck on the floor pane with araldite. Be sure to leave a gap in the partition so that ants may move between the chambers. Fill the nest with loose moist soil and cover with the roof pane. Hold the nest together with rubber bands. Cover the brood chamber with red glass or with dark paper, for although the ants forage in the light, they like to stow their eggs, pupae, and queen in the dark. After you have put your ants in the nest make a plug of cotton or blotting paper to prevent their escape. The cotton plug may also be kept moist to assure that the ants have enough moisture. It may be soaked in sugar solution to supply food.

Another type of 'formicarium' (term for artificial nests for keeping ants) is made from plaster of Paris. Make a network of rolls of plasticine on glass. Wherever two rolls cross, put a ball of plasticine. Build a wall of plasticine round the glass. Mix some plaster of Paris and pour into the mould. The next morning, turn the mould over and remove the glass and the plasticine. Replace the glass on top of formicarium. It is now ready for use. Lift the glass to put in food. Moisten the plaster once a week with water. At the same time, take away any stale food or dead ants. After every two or three months transfer the ants to a jar and wash the formicarium and the glass cover with soapy water. Rinse both with cleanwater before. Do not keep in strong light or sunshine.

### Collection of Ants

Locate an ants nest, preferably of one of the species which do not bite too hard. Dig up the nest carefully with a towel and transfer to a paper bag. Get to the heart of the nest which contains the broad, ignore the fleeing workers and get enough ants for your formicarium. Carry the bag safely to your home or laboratory taking care not to injure the ants while transporting.

### Maintenance of Formicariums

Formicarium should not be kept in too bright light. It should not be too dry or else the ants will die, nor too wet, when moulds will grow.

Food for ants is no problem. They can be fed on jaggery/sugar/syrup. In case of certain ants fine cereals may be substituted. Ants also need a certain amount of protein in their diet. This may be given in the form of small meaty bone or better still in the form of dead insects.

Ants normally breed in a dark place. Therefore, the formicarium or atleast a part of it should be kept dark. Interestingly however the ants eyes are insensitive to the red end of the spectrum. Therefore, you can cover the breed-

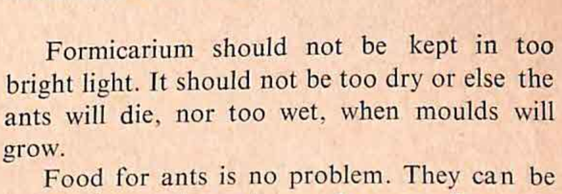


*Fig. 3*

ing area with a red glass or cellophane, and observe activities in the brood room.

**Observations**

Ants are social insects and therefore their daily life nest organisation etc. It is also interesting to observe their food habits. How do they treat intruders? Put in one or two other insects into a formicarium, or even ants from a different nest. What are their reactions? If you can find the original nest from where your lot was collected, get a few ants from that colony and see how the ones in the formicarium react to them. How do ants behave on a dry sunny day, just before rain, and on a wet day? How do ants communicate with each other? These and many other problems can keep you busy once you have established a colony of ants in a formicarium.

□

**Students' Corner**

# How Good are You in Science ?

*How good are you in science has been introduced as a regular feature. You can use it for fun or prepare yourself for a test. Score the answers and check up with the given key.*

1. Diamond and graphite differ because

(a) graphite is impure carbon
(b) carbon has a different valency in the two forms
(c) the atoms in diamond are larger than those in graphite
(d) the number of neutrons in the carbon atom varies in the two forms
(e) the atoms of carbon are differently arranged in the two substances

2. The process of distillation involves

(a) filtration and evaporation
(b) evaporation and condensation
(c) condensation and decantation
(d) decantation and filtration
(e) none of these pairs in the order given

3. The statement, 2 volumes of hydrogen+ 1 volume of oxygen form 2 volumes of steam, illustrates the laws named after

(a) Avogadro
(b) Boyle
(c) Gay-Lussac
(d) Cannizzaro
(e) Dalton

4. Which of the following alloys does *not* contain copper?

(a) brass
(b) duralumin
(c) bronze
(d) "silver" coins
(e) solder

5. Which of the following properties apply to $CO_2$ ?

(a) soluble in water, acidic, readily supports combustion
(b) insoluble, does not readily support combustion, non-poisonous
(c) soluble, does not readily support combustion, non-poisonous
(d) soluble, alkaline, puts out a glowing splint
(e) insoluble, acidic, turns lime water milky

6. A deliquescent substance

(a) absorbs a little moisture from the air and becomes odourless
(b) absorbs a lot of water from the air and becomes coloured
(c) absorbs sufficient water from the air to form a solution
(d) gives up its water of crystallization to the air
(e) none of these

7. A culture of bacteria was incubated in a nutrient broth at 35°C. Samples were taken at intervals, in order to estimate the number of cells in the population. The data in Table 1 were obtained.

Table 1 : Bacterial populations

| *Time* (*h*) | *Number of living cells* (*millions*) | *Total number of living and dead cells* (*millions*) |
|---|---|---|
| 0 | 20 | 22 |
| 1 | 21 | 23 |
| 2 | 22 | 24 |
| 3 | 35 | 40 |
| 10 | 750 | 950 |
| 12 | 1000 | 1250 |
| 15 | 1000 | 1350 |
| 20 | 1000 | 1500 |
| 30 | 1000 | 1750 |
| 35 | 500 | 1750 |
| 45 | 50 | 1750 |

Examine the above data and answer questions (i) to (v).

(i) At what time did the bacteria stop dividing?

(a) 12h
(b) 20h
(c) 30h
(d) 35h

(ii) What shape is the population curve for living bacteria ?

(a) a straight line, passing through the origin
(b) a straight line parallel to the horizontal axis
(c) sigmoid
(d) bell-shaped

(iii) What shape is the population curve for all of the bacterial cells (living and dead)?

(a) a straight line, passing through the origin
(b) a straight line parallel to the horizontal axis
(c) sigmoid
(d) bell-shaped

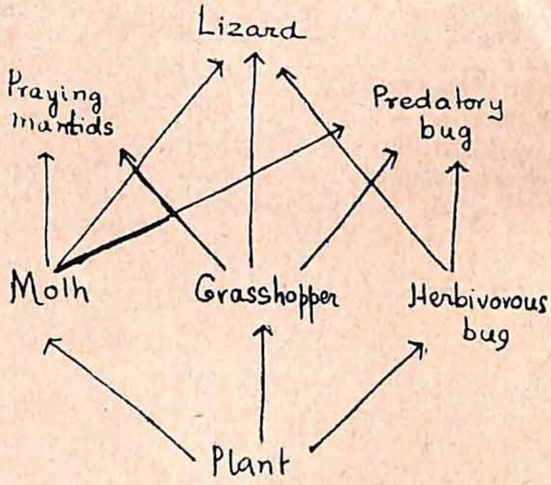
(iv) What shape is the population curve for dead bacterial cells?

(a) a straight line passing through the origin
(b) a straight line parallel to the horizontal axis
(c) sigmoid
(d) bell-shaped

(v) What was the reason for the death of the bacterial cells?

(a) the temperature was too low
(b) the food supply was exhausted
(c) the accumulation of excretory products poisoned the cells
(d) it is impossible to tell from the available data

8. Examine the figure and answer items (i) to (vii)



(i) Which of the following are primary consumers?

(a) grasshoppers and predatory bugs
(b) praying mantids and predatory bugs
(c) moths and praying mantids
(d) herbivorous bugs and moths

(ii) Would you expect to find more

(a) praying mantids than moths
(b) herbivorous bugs than praying mantids
(c) lizards than grasshoppers
(d) moths than plants

(iii) Which one of the following is the primary source of energy?

(a) plants
(b) grasshoppers
(c) praying mantids
(d) lizards

(iv) The praying mantids and the predatory bugs are classified as

(a) top carnivores
(b) secondary consumers
(c) primary consumers
(d) producers

(v) The whole of Fig 1 represents
(a) a habitat
(b) a food chain
(c) a good web
(d) a nitrogen cycle

(vi) The sequence plant-moth-praying mantids-lizard represents
(a) a food web
(b) a food chain
(c) a food niche
(d) a carbon cycle

(vii) Which of the following class of organisms is not represented in the figure?
(a) producer
(b) secondary consumer
(c) decomposer
(d) tertiary consumer

9. A particle is executing simple harmonic motion with a period of 2 sec and an amplitude of 2 mm. Its maximum speed in mm per sec is
(a) $\pi/2$
(b) $\pi$
(c) $2\pi$
(d) $4\pi$

10. During a linear wave motion which of the following is transferred?
(a) matter only
(b) energy only
(c) momentum only
(d) angular momentum only

11. Watt hour is the unit for measuring
(a) force
(b) energy
(c) power
(d) momentum
(e) none of these

12. After reading the passage given below answer questions (i) to (iii)

"Robert Boyle (1627-1691) took a weighed quantity of lead and placed it in a large glass container which he sealed. The container was then heated for some hours. At the end of this period all the lead had changed to a powder. The container was opened and the powder was removed and weighed. The powder weighed more than the lead. Boyle said that heat was the only thing that could have entered the container through the glass and that this was the cause of increase in weight of the lead".

13. (i) Boyle's conclusion was wrong because
(a) glass is a non-conductor of heat
(b) lead does not burn when heated in air
(c) powders are always heavier than metals
(d) something other than heat did enter the container
(e) he was not aware of change of pressure in the flask.

(ii) Boyle would probably not have come to this conclusion had he
(a) weighed a piece of metal cold and then hot
(b) weighed the container before and after removing the stopper
(c) performed the experiment without sealing the container beforehand
(d) a and b
(e) a, b and c

(iii) The increase in weight mentioned in the passage is due to
(a) the expansion of the metal when heated
(b) the fact that lead is now powdered and therefore occupies more volume
(c) the weight of the gas taken from the air by lead
(d) the fact that there was a mixture of gas in the container
(e) the fact that the heating was carried out in 9 glass container.

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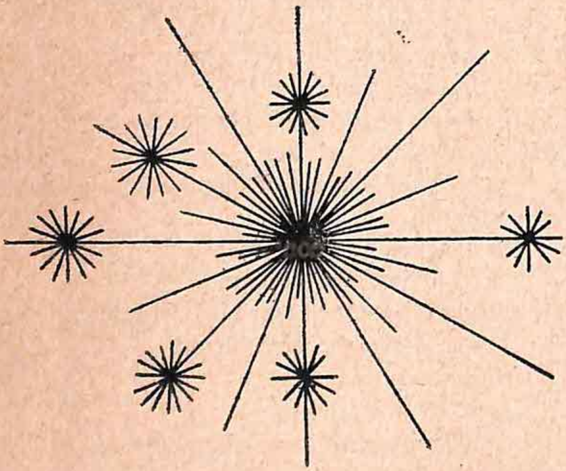
(Answers on page 72)

## Science News



### Giant Star Discovered

New evidence gathered by satellite indicates that a nearby galaxy may contain the heaviest star even discovered, three astronomers of University of Wisconsin say.

Dr. Joseph Cassinelli, Dr. John Mathis and Dr. Blair Savage reached the conclusion after studying data from the US launched international ultraviolet explorer satellite. The satellite gathers light at wavelengths which cannot penetrate the earth's atmosphere.

The three scientists are proposing that a massive star about 30 times heavier than any other star known, is the only way to explain a high speed wind of ionized gas being blown out of a cloud of glowing gas known as the Tarantula Nebula in the large Magellanic Cloud, nearby galaxy.

The large Magellanic Cloud is visible to the naked eye as a fuzzy patch in the sky over the earth's southern hemisphere.

Dr. Lowell coherty, chairman of astronomy at Wisconsin said the scientists believe that a starlike patch of light known as R136A is in fact a massive star which is emitting the gas in much the same way that the sun emits gas called the solar wind.

The astronomers told a meeting of the American Astronomical Society in Albuquerque, New Mexico that this star could produce 40 times as much energy as any known star or 156 million times as much energy as the sun. It would be 3,500 times heavier than the sun and have a radius 120 times as large.

Dr. Doherty said this would make it about 30 times heavier than the most massive known stars. It would not, however, be the largest star. That distinction belongs to the class of stars known as Red Giants, which can have a radius larger than the orbit of the earth.

The people, who deal with how stars are formed, do not expect that much matter to come together in one place". Dr. Doherty said, "If this holds up, it may mean we have to rethink how stars collect matter".

### Minerals below Thar Desert

Geologists have discovered a massive bed containing trillions and trillions of tons of rock salt 100 metres below the Thar desert. The salt bed which is some 500 metres thick, occupies an area of some 80,000 square kilometers under the desert sands, according to Dr. V. S. Krishnaswami, Director-General of the Geological Survey of India.

Dr. Krishnaswami told the Indian Science Congress the top layer of the salt bed contained a fantastic amount of "potash". The potash analysed so far was not suitable for fertilizer use. "but we are confident in locating in the control part of the basin the kind of potash that can be used as fertilizer.

Even if a fraction of potash is exploited, India will have an unlimited supply of the valuable fertilizer.

Dr. Krishnaswami said that the GSI had launched a major project aimed at exploiting the potash under the Rajasthan desert four holes had already been drilled to a depth of 900 metres under what was said to be one of the most difficult operations in desert conditions.

The GSI was already having discussions with the ministries about how to exploit the gigantic reserves of rock salt lying below the layer of potash.

Apart from potash a very large deposit of the strategic material "tungsten" has been discovered by the GSI in the Sirohi district of Rajasthan. The geologists have also made an accidental discovery of a "massive belt" of lead and zinc in Agucha area.

## Earthquake and Dam Water level

Earthquakes in Koyna Dam region in Maharashtra are triggered whenever the reservoir is filled too rapidly according to the latest evidence obtained by scientists of the National Geophysical Research Institute in Hyderabad.

Dr. H. K. Gupta, Head of the NGRI, Seismology Department told the Science Congress that all the three Koyna earthquakes in 1967, 1973 and 1980 had occurred when water level rose at the rate of over 40 feet per week. By just preventing such rapid increase in the reservoir water level, it may be possible to prevent earthquake happening in that region, Dr. Gupta said.

The NGRI study on reservoir induced earthquake all over the world has revealed that tremors due to impoundment of water have been caused in over 40 dams.

The well-known among them are Koyna in India, Kremasta Dam in Greece, Kariba Dam in Nigeria-Rhodesia border, Nourek Dam in the USSR and Hsingfengklang Dam in China.

Dr. Gupta said that Nourek Dam in Russia had experienced a quake in 1972. Since then there had been no major earthquake at the dam site despite the maximum water level in the dam because the Soviet scientists had been carefully loading and unloading the reservoir. He recommended a similar approach to prevent recurrence of Koyna earthquake.

The Planning Commission has suggested the formation of a consortium of the 400 scientific associations to enable young scientists to take part in national developmental projects.

## Air Pollution can Cause Reproductive Disorders

A Calcutta scientist asserts that environment pollutants can cause reproductive disorders by directly or indirectly affecting the reproductive organs. In a paper on the effects of environmental pollutants on male reproduction, submitted to the Science Congress, Mr. A. K. Chowdhury says that many compounds such as organchlorine derivatives and cyclodieene organophosphates have been found to cause physical abnormalities like chromosomal breakage because of pollution. Most of these compounds are yet to be investigated.

The paper claims that compared to animals, humans have poor quality semen. Even in a fully fertile man, 20 to 35% structurally abnormal sperms are present compared to less than 5% in most animal species.

Recent works show that at least in part, human infertility is caused by gene mutation, produced by mutagenic agents. In some cases, agents with no mutagenic property also produce abnormality of sperm morphology.

### X-Ray Prints on Plain Paper

A process for duplicating X-ray images on plain paper using ordinary photocopying machines has been developed at the All India Institute of Medical Sciences in New Delhi. The X-ray copies on white paper can be obtained for only 50 paise a copy which is several times cheeper than the photographic films being used presently, it is claimed.

The process developed by Dr. M. A. Padmanabha Rao of the AIIMS Nuclear Medicine Department involves an optical attachment to the Xerox machine. The attachment enables the light to pass through the X-ray film. For normal duplicating purposes light is usually reflected from the documents.

### New Tree for Fuel and Timber

Ipil-Ipil (Leucocaena leucocephea) a fast growing tree from Central America, may prove to be the answer to India's increasing demand for industrial and fuel wood.

The Gujarat Forest Department, which has raised several experimental plantations of Ipil (botanically known as Leucocaena leucocephea), organized a seminar on Ipil at Gandhi Nagar near here jointly with the Swedish International Development Authority (SIDA) and the Forest Research Institute of Dehra Dun.

The spokesman said SIDA was currently sponsoring a project supplying seed of Ipil-Ipil to India from the Philippines where high yielding strains had been developed of the 2.5 tonnes of seed imported last year. Gujarat received half a tonne for its forestry programme. It is proposed to import 20 tonnes of seed under the project.

Ipil-Ipil produces straight small timber and its leaves are excellent fodder. Being leguminous, it enriches the soil. Successful trials have been conducted on the species in Kerala, West Bengal, Maharashtra and U.P. The spokesman said the seed and pods of Ipil-Ipil were edible. The pods yield gum and a dye which is used to colour wool, cotton and fishing nets.

The tree grows under a variety of conditions, but being essentially warmth-living, is restricted to the tropics and sub-tropics. It withstands large variations in rainfall, soil salinity and terrain conditions.

The plant has considerable salt resistance and grows in exposed coastal areas—often right down to the high water mark.

Ipil-Ipil's overall potential has yet to be assessed and many more test trials need to be conducted.

A Gujarat Forest Department spokesman said India was in a critical position as far as forest resources were concerned. The National Commission on Agriculture had projects a demand of 47 million cubic metres of industrial wood by the year 2000 assuming a low rate of income growth. If natural forests were worked intensively, the maximum annual yield would be around 21 million cubic metres leaving a gap of 26 million cubic metres of fuel wood.

### A new varity of Spinach Evolved

The Indian Agricultural Research Institute (IARI) has evolved a new variety of spinach (*Palak*) which, besides being high-yielding, is more nutritious than existing popular types. Called Pusa Jyoti, the new variety has larger-size leaves than the popular variety, "all green". Its leaves are green, thick, tender, succulent and crisp. It tastes good even when eaten raw and can be used as salad. When cooked, it gets easily minced and develops nice flavour, colour and edible qualities. It is claimed to be highly nutritious.

The Pusa Jyoti plant is vigorous and quickly regenerates after each cutting. According to

IARI sources, the crop performs best in winter although it can be raised the year round. The leaf yield is over 48 tonnes a hectare, against about 38.7 tonnes a hectare of "all green" variety.

The crop grown for leaf has been found to be largely free from diseases and pest attack. The crop raised for seed in northern states is, however, likely to get black dots on the leaves around late March. Spray of copper fungicides or Bordeaux mixture can help avoid it. Diseases like mildew and rusts are not common on this variety. However, dusting of sulphur of spraying of copper fungicides can help check these diseases also. The attack of "Damping off" can be controlled in young seedlings by treating the seeds with suitable chemicals.

### Food from Artificial Protein

The scientists of the food laboratory of the institute of organoelemental compounds of the USSR Academy of Sciences have worked out general methods of obtaining meat products from proteins, both natural and industrial. The team was led by Prof. Vladimir Tolstogyzov.

Though by themselves some proteins are not edible, and have no colour, taste or smell, in combination with other susbtances, they can have the taste of meat.

The scientists of the institute have studied the basic physical and chemical properties of food proteins and the molecular forces which impart natural food products their specific structure. After studying the basic laws governing the conduct of proteins in different conditions, they have found efficient means for the industrial production of artificial food proteins.

Researchers are engaged in obtaining a fibrous protein foundation for preparing various meat products which do not differ from natural ones in appearance or consistency. They have also studied the laws governing the frying processes of food materials by which various chemical substances producing specific smell are formed. This has enabled them to select the composition of artificial products which might produce the same flavour and smell as the natural food products.

In fact, the amount of protein produced in the world does not meet the human requirements, for the traditional farming methods have an extremely low efficiency. In an isolated state, even grass could be kept for an unlimited time like starch or fat, and when needed it could be easily turned into products similar to natural meat products. The scientists conclude that it is possible to make artificial cereals, macaroni products, potatoes, berries, sweets and milk out of protein isolates. This virtually means a fuller use of natural food and a sharp reduction of its losses in the course of processing and storage.

### Stone Disease Highiest in Rajasthanis

The incidence of stone in the gall bladder among residents of Rajasthan is perhaps the highest in the world, according to renowned urologist, Dr. W. A. Milner.

Dr. Milner was talking to reporters after opening the "Hamaturia diagnositic service" sponsored by the Urology Services Society. A modern cytology laboratory is also being established to help in screening cases.

He has suggested that people should be educated to take more liquids and the quality of potable water be improved to check the disease.

Dr. Milner praised the work done by the Rajasthan Urology Service Society in taking urology service to rural areas.

### Laser Surgery

Soviet scientists and designers have developed a laser koler which can perform most complex and minute operations on the retina with precision.

The one-square-millimetre "yellow spot" in the eye retina is responsible for 95 per cent of human eyesight hence expertise and accuracy of a very high order is required in such surgical operations. And laser offers such accurate operation.

Scientists have determined all possible variants of the operation with the help of a computer. This programme helps determine the intensity, duration and shape of the laser impulse.

The optical quantum generator has been tested in operation at the Filatov Research Institute for eye diseases and tissue therapy in Odessa and has been highly appraised by experts.

## A Rare Bird dies in Capitvity

Dr. Gustavo Del Solar and Professor John O'Neill of the University of Louisiana started ornithologists in 1977 by discovering several dozen white-winger Guans (*Penelope albipennis*), which naturalists had considered extinct for 100 years.

A recent count of the birds in northern Peru sponsored by the New York Zoological Society revealed there are only between 49 and 62 of them left.

The Guan's black feathers radiate a green glow in bright sunshine. They have red legs and toes, a purpose head and an orange throat, their wings each have eight snow white feathers.

Mr. Gustavo Del Solar, a big game hunter and wildlife preservationist, said his pet white-winged Guan, a type of turkey died last Monday on his ranch in northern Peru. The bird had haemorrhaged after laying an egg four days earlier.

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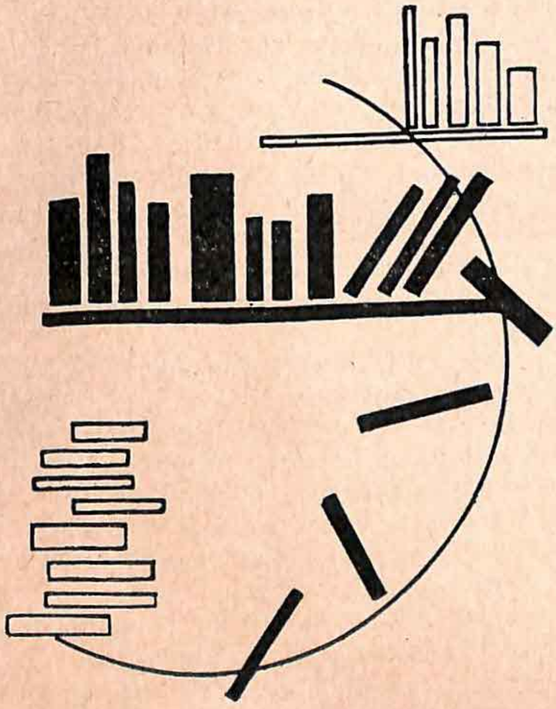
**Answers**

1(e); 2(b); 3( ); 4(e); 5(c); 6(c); 7(i)c, (ii)d, (iii)c, (iv)c, (v)d; 8(i)d; (ii)b; (iii)a, (iv) b, (v) c, (vi) b, (vii) c; 9(c); 10 (b); 11(b); 12(i) e, (ii) e, (iii) c.

# Book Review



## Nature Day and Night

Richard Adams with Max
Hooper and David Goddard.
Penguin Books Pp. 108, £ 2.50.

WHY DO certain flowers like daisies close at night or in heavy rain ? Why do butterflies fly by day and moths by night or how do the eyes of insects and birds differ from those of human beings?

These are some of the questions raised and answered in a new and picturesque book on everyday science that we see around ourselves. The setting of the book in England and to that extent some of the animals and plant species described and beautifully illustrated in this book will not be familiar to an Indian reader. That will take away the pleasure of reading the book to a slight extent, but only very slightly. Most of the other examples of the biological life given are not special to any particular environment and are found almost anywhere, and certainly in the tropical climate in India with its wide variety of fauna and flora.

The style of the book seems to be to lead the reader on an exploratory trip through the meadows, the woodland, the mountain stream and the sky by day and by night. The author writes—"I am making a kind of pilgrimage. Starting near the foot of the glen, not far from where the stream runs into the larger river, I mean to follow the banks—and in places probably the actual bed—of the stream, almost upto its boggy, peaty sources on the moor. I'm carrying a short, split-cane rod and I may, as Bertie Wooster would say, drop the casual worm into the odd pool, in case there happens to be trout on the feed...."

In this adventure, the author, ably assisted by the illustrator, David Goddard points out at the different animals, the birds, the insects, fish and other living beings that appear in the meadow or the stream and shows the difference in their behaviors by day and night. In a very simple and precise language, the book tells us many interesting facts about the animal and plant world : how do spiders build their webs and the different patterns of webs that they build; why do birds sing at dawn and how fish can "see" at night-time ?

In answering these questions, the author Richard Adams, often manages to throw in an interesting point about them. For example, although many of us may be aware of regular sequences of the notes of the different "singing" birds like the nightingale or the skylark, we may not have seen their notes written down in actual musical language.

Again, we probably know that our ears are receptive to only certain sound frequencies. But it came as a complete surprise to read that as a child, I probably could hear the shrill, high frequency sound uttered by a bat. Another interesting fact pointed out is that certain insects can navigate even on a cloudy day by means of their ability to see polarized light.

The different types of the clouds and how and at what heights they are generally formed, has also been described. But clouds are more important for the fantasies that children (and occasionally adults) indulge in while looking at them . In fact, looking at clouds and day-dreaming are often used synonymously by poets and this has been referred to by Richard Adams. However, this day-dreaming and fantasizing are essential components in the conceptual growth of children, as Einstein has written in his memoirs.

The scene in a meadow as the light begins to fall in the late afternoon is well documented. First to appear are "... the meadow fescue, then couch grass and sheep's fescue; later still meadow grass itself. Mice and voles begin to feed amongst the grass, and the tawny owl arrives to hunt them. Snails and slugs appear and the hedgehog appears to hunt them . . ."

What starts these activities? Is it the light, heat or moisture; or is it their internal clock, or is the cause something altogether different? It is explained that slugs, snails and many insects become active in the evening because they would otherwise lose too much moisture during the day—their activities do not depend upon light directly.

One of the attractive and pedagogically sound features of the book, is that the scene is first described and the physical principles that govern the behaviour of the different biological species are then introduced. Thanks to the lead taken by NCERT, this approach is now being followed increasingly in our country at the primary school level. Here, science teaching and learning are integrated with the environment that the child is familiar with either at home or in his neighbourhood or in the school. Another advantage of this approach is that this integrates the various aspects of science—biological, physical, chemical and meteorological etc. into a unified whole.

But occasionally the book departs from this approach also as when it describes the role of the sun in the process of photosynthesis, thus making plants active by day. Since the book deals mainly with biological phenomena, it is not surprising that the evolution theory finds place in it :

"One of the best ways of looking at the plant and animal life is to think of it as a struggle for survival—both for the individual organism and for the species as a whole. Only those which survive to reproduce can be called, successful".

The cruelty—if it can be so called, that operates in this struggle, is brought out elsewhere in a most dramatic language :

"In the wild, every creature is part of the food cycle, either a killer or a victim—often both, and there's no such thing as death from old age. The grim aspect of nature is not, to put it mildly, easy to accept, but to ignore it is to evade the truth and to understand nature less clearly. Killing, eating and survival, that's what it's all about".

Further on, while describing the life style of one of the 36 species of ants found in Britain, this grim reality is reinforced.

"The ants when alarmed and angry exude their formic acid. There's something disturbing about their world, in which every ant fulfils its function and the lives of individuals count for nothing".

Richard Adams has a penchant for quoting poets and writers to reinforce his description of the nature. He refers to Shakespeare and the French novelist Marcel Proust while talking of the clouds and the relationship of the sky to the earth.

This, and the beautiful illustrations by David Goddard make the book come alive. In fact, the illustrations many of which are double page colourful paintings, are an essential part of the book. Without them, the book would not be so fascinating and pleasing. It is a pity that our science books are not so attractive and appealing to the children who are supposed to read them. It would be desirable if this book by Richard Adams would be made available in an Indian edition. The Penguin edition, although moderately priced at £ 2.50 would still be too expensive for the Indian reader.

RAVI P. BHATIA
*Union Public Service Commission*
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